Department of Energy
Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
7295 Highway 94 South
St. Charles, Missouri 63304

February 19, 1992

Addressees:

APPROVED 1992 ENVIRONMENTAL MONITORING PLAN, JANUARY 1992, REVISION 1

Enclosed is the approved 1992 WSSRAP Environmental Monitoring Plan (EMP), Revision 1. The EMP is prepared to ensure that the public's health and safety are protected and that all applicable legal and regulatory requirements are met. The scope of this plan includes the effluent monitoring and environmental surveillance activities that will be performed during 1992. These activities include the monitoring of surface water, groundwater, radon, gamma radiation, air particulate, sediment, biological and meteorological conditions.

Revision 1 updates the text regarding analytical accuracy and investigation and detection levels for environmental sample analysis. Please substitute this revision for the plan that you were provided on January 7, 1992.

If you have any questions or desire a meeting to review this plan, please contact Alan D. Gibson at (314)441-8978.

Sincerely,

Stephen H. McCracken
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DOE/OR/21548-237
CONTRACT NO. DE-AC05-86OR21548

ENVIRONMENTAL MONITORING PLAN FOR CALENDAR YEAR 1992

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

JANUARY 1992 **REV. 1**

U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

MORRISON KNUDSEN CORPORATION
MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: January 6, 1994

TO: File

FROM: Michelle French MF

SUBJECT: **CORRECTIONS TO WELDON SPRING ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1992**

Recent evaluation of the Weldon Spring Site Environmental Report for Calendar Year 1992 has revealed an error in the units given in two tables in Section 4.0. The units of "$\mu Ci/ml$" in Tables 4-5 and 4-6 on Pages 75-82 should read "$\mu Ci/m^3$". This errata sheet will be included in further reproduction of the above mentioned document and be maintained in Document Control for reference.

MF/jn

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PLAN TITLE: Environmental Monitoring Plan for Calendar Year 1992	

APPROVALS

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DOE/OR/21548-237

Weldon Spring Site Remedial Action Project

Environmental Monitoring Plan for Calendar Year 1992

Revision 1

January 1992

Prepared by

MK-FERGUSON COMPANY
and
JACOBS ENGINEERING GROUP
7295 Highway 94 South
St. Charles, Missouri 63304

for the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

ABSTRACT

Environmental monitoring plans have been formulated annually since the inception of the Weldon Spring Site Remedial Action Project (WSSRAP) to ensure that the public's health and safety are protected and that all applicable legal and regulatory requirements are met. These plans have evolved over the years as characterization activities have defined the extent and magnitude of contamination.

This 1992 Environmental Monitoring Plan satisfies requirements of the U.S. Department of Energy (DOE) Order 5400.1 requiring each DOE facility with the potential for contributing to environmental pollution to prepare an environmental monitoring plan for its program.

The scope of this plan includes the effluent monitoring and environmental surveillance activities that will be performed during the 1992 environmental monitoring year (calendar year). These activities include the monitoring of surface water, groundwater, radon, gamma radiation, air particulate, sediment, biological and meteorological conditions.

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1 INTRODUCTION

The Weldon Spring site (WSS) is located near Weldon Spring, Missouri, 30 mi west of St. Louis, Missouri. The WSS consists of an inactive uranium production facility including raffinate pits, a chemical plant, an abandoned limestone quarry, and associated vicinity properties. These areas contain chemically and radiologically contaminated materials originating from previous operations at the site.

Remediation of the Weldon Spring site was designated as a Major Project in May 1985. It has since been designated by the U.S. Department of Energy (DOE) as a Major System Acquisition. The program is known as the Weldon Spring Site Remedial Action Project (WSSRAP). The major goals of the WSSRAP are to eliminate potential hazards to the public and the environment, and to make surplus real property available for other uses to the extent possible. An environmental documentation approach has been developed that satisfies the requirements of both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) and the National Environmental Policy Act (NEPA). The result of this process will be a Record of Decision regarding ultimate disposal of the WSS wastes.

DOE Order 5400.1, *General Environmental Protection Program* requires the preparation of an *Environmental Protection Program Implementation Plan* (EPPIP) at all DOE sites. The Weldon Spring site EPPIP (MKF and JEG 1991a) details the methods by which the WSSRAP will comply with this order. Because the WSSRAP is a remedial action project, the overall goal is different from the standard operating and/or production facilities for which DOE Order 5400.1 was developed. Therefore, the WSSRAP EPPIP meets the intent of DOE Order 5400.1, while being tailored to the unique aspects of a remedial action project. The WSSRAP has prepared this *Environmental Monitoring Plan* (EMP) to meet the requirements for DOE environmental monitoring programs as specified in DOE Orders 5400.1 and 5400.5 and the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991), hereafter referred to as the *Regulatory Guide*.

1.1 Purpose

DOE Order 5400.1 requires the preparation of an *Environmental Monitoring Plan* to define the effluent monitoring and environmental surveillance required to demonstrate compliance with applicable Federal, State and local environmental protection laws and regulations, Executive Orders, and internal DOE policies.

The purpose of this *Environmental Monitoring Plan* is to detail the environmental monitoring requirements at the WSS. Environmental monitoring is performed at the WSS to ensure that any potential public exposure is documented and quantified, to ensure that the public's health and safety and the environment are protected, and to demonstrate compliance with applicable legal and regulatory requirements. The monitoring program also confirms adherence to DOE environmental protection policies, and supports remedial planning.

1.2 Scope

This plan describes the effluent monitoring and environmental surveillance activities that will be performed at the WSS during calendar year 1992. These activities include monitoring of surface water, groundwater, radon, gamma exposure, air particulate, sediment, and meteorological conditions. The plan also describes applicable monitoring requirements, analytical methods used, and quality assurance measures. Details and rationale regarding sampling frequencies and analytic parameters are provided. Also presented are summaries of additional programs implemented to satisfy the requirements of DOE Order 5400.1, Order 5400.5, and the *Regulatory Guide*. An evaluation of compliance or non-compliance with each regulatory guide criteria statement was not included in the 1992 EMP. Where criteria statements were applicable to the WSSRAP, recognition of satisfying the criteria was included. The 1993 EMP will include a more detailed evaluation of the criteria statements.

1.3 Site History

In April 1941 the Department of the Army (DA) acquired 17,232 acres of land where, from November 1941 through January 1944, Atlas Powder Company operated a trinitrotoluene (TNT) and dinitrotoluene (DNT) explosives production facility known as the Weldon Spring Ordnance Works (WSOW). By 1949 all but approximately 2,000 acres had been transferred to the State of Missouri (August A. Busch Memorial Wildlife Area) and the University of Missouri (agricultural land). Except for several small parcels transferred to St. Charles County, the remaining property became the Weldon Spring U.S. Army Reserve and National Guard Training Area (WSTA).

Through a Memorandum of Understanding between the Secretary of the Army and the General Manager for the Atomic Energy Commission (AEC), 205 acres of the former WSOW were transferred in May 1955 to the AEC for construction and operation of the Weldon Spring Uranium Feed Material Plant (WSUFMP) to process uranium and thorium ore concentrates. Considerable explosives decontamination was performed by Atlas Powder and the DA prior to WSUFMP construction.

The WSUFMP was an integrated facility for converting processed uranium ore concentrates to pure uranium trioxide, intermediate compounds, and uranium metal. A relatively small amount of thorium was also processed. Wastes generated during these operations were stored in four raffinate pits.

In 1958 the AEC acquired title to the Weldon Spring Quarry (WSQ) from the DA. The WSQ had been used earlier by the DA for disposal of TNT-contaminated rubble during the operation of the WSOW. The AEC used the WSQ as a disposal area for a small amount of thorium residue, but most of the material disposed of there consisted of uranium and radium-contaminated building rubble and soils from the demolition of a uranium ore processing facility in St. Louis.

The WSUFMP was shut down in 1966, and in 1967 the AEC returned the facility to the DA for use as a defoliant production plant, to be known as the Weldon Spring Chemical Plant (WSCP). The Army started removing equipment and decontaminating several buildings in 1968.

The defoliant project was canceled in 1969 before any process equipment was installed. The DA retained the responsibility for the land and the facilities at the WSCP, but the 51-acre tract encompassing the Weldon Spring raffinate pits (WSRP) was transferred back to the AEC. The WSS was placed in caretaker status until 1986, when the Weldon Spring Site Remedial Action Project was initiated.

2 OBJECTIVES AND RATIONALE

The goal of the Weldon Spring Site Remedial Action Project (WSSRAP) is to protect and enhance the environment while ensuring the protection of the public. This will be accomplished by safely disposing of hazardous and radiological wastes that resulted from operation of the Weldon Spring Uranium Feed Materials Plant and the U.S. Army's ordnance operation. Within the overall project mission, the environmental protection program focuses on the operational activities of the project.

The WSSRAP objectives for the environmental protection program are as follows:

- To assess compliance with all applicable environmental quality standards and public exposure limits.
- To determine the background levels and site contributions of contaminants.
- To determine the effectiveness of effluent treatment and controls.
- To determine the validity and effectiveness of models.
- To determine the long term buildup and prediction of environmental trends from site-released contaminants.
- To accomplish the detection and quantification of unplanned releases.

It is the purpose of this EMP to describe the rationale and design criteria for the monitoring program; determine the extent and frequency of monitoring and measurements; outline the procedures for laboratory analyses, quality assurance requirements, program implementation procedures, and preparation and disposition of related reports.

The WSSRAP environmental protection program is separated into two distinct functions: (1) effluent monitoring, and (2) environmental surveillance. Effluent monitoring assesses the quantities of substances in a migration pathway from the site at the facility boundary, or in a pathway subject to compliance with applicable regulations (e.g., National Emissions Standards for Hazardous Air Pollutants [NESHAPs]) or permit levels and requirements (e.g., National

Pollution Discharge Elimination System [NPDES]). The environmental surveillance program generally reviews environmental media within or outside the facility boundary for the presence and concentration of site contaminants to detect and/or track the migration of those contaminants. Surveillance data are used to assess the presence and magnitude of any radiation or toxicological exposures by members of the public, or to assess the effects, if any, on the local environment.

The Weldon Spring site (WSS) has maintained a relatively stable configuration of its waste products since cessation of the plant operation and decontamination of some process buildings in the early 1970s. It is believed that this stability has allowed the site to achieve a rough equilibrium regarding the migration of contaminants from the site. Since the WSS is presently under active remediation, the nature of the waste units and their physical position and chemical state are subject to disturbance. The monitoring program for 1992 has been designed to address the pathways and constituents reflective of a changing waste setting.

The U.S. Department of Energy (DOE)has defined generic performance criteria that the DOE operations offices must use in developing their programs. The environmental protection program has incorporated these criteria into the WSSRAP monitoring program. The objective of the WSSRAP environmental monitoring program is to generate all data necessary to ensure regulatory compliance, and assess the public and environmental impact of site contaminants. Therefore, a program must be developed that assesses all viable environmental pathways. The program in this EMP defines a minimum scheme of data points to be collected to evaluate whether environmental conditions are changing and whether WSS-related contaminants or activities are impacting public health or the environment. Where additional data points or density is required to verify trends or more closely evaluate environmental conditions, additional samples may be collected that are not defined in the plan. Those samples will be collected to serve the objectives of the environmental/monitoring program at the Weldon Spring site and will be consistent with the guidelines of the DOE 5400 orders. The following section describes the pathway analysis performed by the WSSRAP to arrive at the monitoring program.

2.1 Pathway Analysis

To evaluate the potential impact on human or ecological receptors of activities at the WSS it is necessary to conduct a pathway analysis. Exposure pathways are identified considering the source, release mechanisms, type and location of contaminants at the site and the probable environmental fate (persistence, partitioning, transport and intermedia transfer) of these contaminants; and the location and activities of potentially exposed receptors. See Table 2-1 for matrix of factors considered for the exposure pathway screening process. The primary objective of the pathway analysis is to identify those pathways that are, or may be "complete" under current conditions and given reasonable assumptions about future conditions. An exposure pathway is considered complete if a linkage can be shown between one or more contaminant sources, through one or more environmental transport processes, to an exposure point where human or ecological receptors are present.

Identification of potentially complete pathways is a qualitative judgement. Procedures used are intended to be conservative. The identification of a complete pathway does not necessarily indicate that adverse effects will occur; it indicates that the effort to monitor releases is worthwhile from the standpoint of protecting human health and the environment.

Separate pathway analyses were conducted for the WSQ and the WSCP. Results of these analyses are presented in Tables 2-2 and 2-3.

2.2 Monitoring Program Rationale

The critical pathway analysis (radionuclide and media) for the WSSRAP site was conducted for the Weldon Spring Quarry (WSQ) and the Weldon Spring Chemical Plant (WSCP). These analyses were based on data developed during various characterization studies (e.g., Phase I and II soils study, groundwater study, etc.), site specific criteria, site specific assumptions and the matrix of potential exposure routes (see Table 2-1).

Site specific criteria considered in this pathway analysis included physical, chemical, and biological characteristics of the radionuclides detected; spatial distribution; concentration; depth to groundwater; geology of the area; climatic conditions; area use by public and wildlife; and the proximity of contaminated sites to potential receptors.

Site specific assumptions for this analysis were as follows:

- Off-site residents have no access to the contaminant source areas.
- Access of large game animals to contaminant source areas is limited by perimeter fencing.

Table 2-1 Potential Exposure Route Matrix

Component of Exposure Assessment	Factors to be Considered
Affected Environmental Media	Air Groundwater Surface Water Sediment Surface Soil Subsurface Soil Aquatic Biota Terrestrial Biota
Release Mechanism of Medium	Air - Volatilization, fugitive dust. Groundwater - Groundwater flow, discharge to surface water. Surface Water - Surface runoff overland flow, groundwater seepage, partitioning with sediment, volatilization. Sediment - Surface runoff overland flow, groundwater seepage leaching, partitioning with surface water, release to biota surface disturbance. Surface soil - Fugitive dust transport/depository, surface runoff, overland flow leaching, surface disturbance. Subsurface soil - Leaching. Aquatic biota - direct contact, ingestion. Terrestrial biota - direct contact, ingestion.
Contaminant Transport Pathway	Airborne transport Groundwater migration Surface water flow Sediment Transport Fluid migration through subsurface soil Surface soil erosion Transport of aquatic biota Terrestrial biota migration

Table 2-1 Potential Exposure Route Matrix (Continued)

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Component of Exposure Assessment	Factors to be Considered	
Contaminant Fate and Transport	Physical	- Volatilization Sorption, surface complexation.
	Chemical	- Photolysis oxidation/reduction Hydrolysis Dissolution/precipitation Ion exchange, chemical portioning Aqueous complexation Chemical degradation Hydration
	Biological	- Bioaccumulation Biomagnification Biotransformation Biodegradation
Current and future receptors	Human	- On-site workers Off-site residential, recreational, commercial, industrial.
	Ecological	- On-site aquatic, terrestrial biota Off-site aquatic, terrestrial biota
Exposure routes by medium	Air	- Indoor/outdoor vapor phase inhalation, immersion Indoor/outdoor particulate inhalation
	Groundwater	- Ingestion Dermal contact
	Surface water	- Ingestion Dermal contact
	Sediment	- Ingestion Dermal contact
	Surface Soil	- Ingestion Dermal contact Immersion
	Subsurface soil	- Indoor/outdoor vapor phase inhalation.
	Biota	- Ingestion Inhalation Dermal contact Immersion
	Cross Media transfers	

Table 2-2 Weldon Spring Quarry Complete Exposure Pathway Selected for Evaluation

Population Potentially Exposed	Exposure Route, Medium, Exposure Point	Pathway Selected For Evaluation	Reason for Selection
Off-site Residents	Ingestion of groundwater from local wells downgradient from the site.	Yes	Use of groundwater as a source for drinking water by residents.
	Ingestion of game and fish inhabiting wildlife area.	Yes	Ingestion of game animals and fish by residents. Magnitude of exposure is low.
	Inhalation of particulates dispersed through wind erosion and remedial action.	Yes	Inhalation of wind dispersed particulates by nearby residents.
	Dermal contact with airborne and deposited particulates.	No	Dermal contact with radionuclides is not considered to be an important exposure route because off-site concentrations are extremely low or nonexistent.
	Ingestion of surface water and/or sediments.	Yes	Use of lakes on public land which show elevated uranium levels.
Wildlife Area Visitors	Inhalation of particulates dispersed through wind erosion and remedial action.	Yes	Inhalation of airborne particulates by visitors of wildlife area.
	Dermal contact with sediment in slough, creek.	No	Dermal contact with sediment in slough, creek while wading or swimming. Exposure potential is low since wading or swimming in these areas is prohibited.
	Ingestion of surface water while swimming.	No	Potential for ingestion of surface water (slough, creek) is low since this activity is prohibited in these areas.
Terrestrial Biota (on site)	Ingestion of surface waters and sediments.	Yes	Potential use of surface water as drinking water by biota and ingestion of sediment.
	Ingestion of vegetation and soils.	Yes	Use of vegetation as food source and incidental ingestion of soils. Inhalation route for biota is not considered to significantly contribute to overall dose.

Table 2-2 Weldon Spring Quarry Complete Exposure Pathway Selected for Evaluation (Continued)

Population Potentially Exposed	Exposure Route, Medium, Exposure Point	Pathway Selected For Evaluation	Reason for Selection
Terrestrial Biota (off site)	Ingestion of surface water and sediments.	Yes	Use by biota of area surface waters as drinking water and incidental ingestion of sediments.
	Inhalation of airborne particulates due to wind erosion and soil disturbance.	No	Inhalation route for biota is not considered to significantly contribute to overall dose due to extremely low or non-existent concentrations.
	Ingestion of vegetation and soils.	Yes	Use of vegetation as food source and incidental ingestion of soils.
Aquatic Biota (on site)	Uptake of surface water and contact with sediment.	Yes	Absorption through contact with surface water and sediment in the quarry.
	Ingestion of invertebrates and vegetation.	Yes	Ingestion of invertebrates and vegetation is an important uptake mechanism.

TABLE 2-3 Weldon Spring Chemical Plant Area Complete Exposure Pathways Selected for Evaluation

Population Potentially Exposed	Exposure Route, Medium, Exposure Point	Pathway Selected for Evaluation	Reason for Selection
Off-site Residents	Ingestion of game animals and fish inhabiting wildlife area.	Yes	Ingestion of game and fish by residents. Contribution to exposure considered low.
	Inhalation of particulates dispersed through wind erosion and remedial action.	Yes	Inhalation of airborne particulates by nearby residents.
	Dermal contact with airborne and deposited particulates	No	Dermal contact with radionuclides is not considered an important uptake mechanism.
	Ingestion of surface water and contact with sediment while swimming or wading.	No	Exposure potential for ingestion of surface water/contact with sediment is low since swimming or wading in Busch lakes is prohibited.
	Ingestion of food crops adjacent to area.	Yes	Potential use by local residents of food crops grown adjacent to site.
Wildlife Area Visitors	Inhalation of particulates dispersed through wind erosion and remedial action.	Yes	Inhalation of airborne particulates by wildlife area visitors.
	Ingestion of game and fish inhabiting wildlife area.	Yes	Ingestion of game and fish inhabiting wildlife area collected during hunting/fishing season.
	Ingestion of surface water and contact with sediments while swimming or wading.	No	Exposure potential through ingestion of surface water/contact with sediments in Busch Lakes for visitors is low since these activities are prohibited.
	Dermal contact with airborne and deposited particulates.	No	Dermal contact with radionuclides is not considered a significant uptake mechanism.
Terrestrial Biota (on site)	Ingestion of surface water and ingestion of sediments.	Yes	Ingestion of raffinate pits surface water and sediment by biota.
	Ingestion of vegetation and soils.	Yes	Use of vegetation as food source and incidental ingestion of soils.

TABLE 2-3 Weldon Spring Chemical Plant Area Complete Exposure Pathways Selected for Evaluation (Continued)

Population Potentially Exposed	Exposure Route, Medium, Exposure Point	Pathway Selected for Evaluation	Reason for Selection
	Inhalation of airborne particulates dispersed through wind erosion and remedial action.	No	Inhalation route for biota is not considered to significantly contribute to overall dose.
Terrestrial Biota (off site)	Ingestion of surface water and sediments.	Yes	Use of area surface water as a source for drinking water and incidental ingestion of soils.
	Ingestion of vegetation, crops, and soils.	Yes	Use of vegetation and crops as food source and incidental ingestion of soils by biota inhabiting the wildlife area.
	Inhalation of airborne particulates due to wind erosion and soil disturbance.	No	Inhalation route for biota is not considered to significantly contribute to overall dose.
Aquatic Biota (off site)	Uptake of surface water and contact with sediments.	Yes	Uptake by biota inhabiting surface water in wildlife area.
	Ingestion of invertebrates and vegetation.	Yes	Ingestion of invertebrates and vegetation is an important uptake mechanism.

- Prolonged or year round use of on-site water bodies by waterfowl is limited.

- Frequency and duration of wildlife area visits per individual is low (MDOC 1991).

- Consumption of game animals and fish per individual averaged over a year is low.

The monitoring programs described in the following subsections were designed with specific knowledge of the active pathways and the pathway analyses performed. Each media-specific monitoring and analysis program follows a general rationale.

2.2.1 Surface Water

Surface water is influenced by three general mechanisms; the monitoring program for 1992 will address each mechanism independently. Surface water is impacted by water that flows from the site and carries with it site-source contaminants and contaminants deposited in the sediments of the stream channels. Small quantities of water migrate from the site on a regular basis due to human influenced activities, such as the permitted, treated effluent from the on-site DOE administration building. Finally, surface water is impacted by the discharge of contaminated groundwater to surface water receptors at springs around the area of the site. Each feature receiving surface water is sampled and contaminant levels measured. The migrating surface waters are subsequently sampled along their course to track their behavior until the concentrations are diluted or otherwise rendered indiscernible from background levels.

2.2.2 Groundwater

The groundwater and hydrogeology beneath the site have been studied extensively. The present conceptual model of the hydrogeologic regime incorporates the activity of diffuse flow through the fractured limestone and the influence of discrete groundwater movement through solution enlarged fractures and conduits. The rationale for groundwater monitoring is to capture the influences of the on-site contaminant sources on the groundwater through the use of conventional monitoring wells around those sources and around the site perimeter. Converging conduits transport water, which transitions from diffuse flow to discrete flow, to springs previously mentioned. Proper monitoring of the resurging water at those springs satisfies the other mechanism of groundwater movement.

2.2.3 Air and Atmospheric Migration

Air pathway and atmospheric migration of contaminants and radiation constitute a broad set of exposure pathways. Characterization studies conducted over the past four years have determined that the only significant sources for airborne contamination from the WSS-related wastes lie within the boundaries of the WSCP/WSRP and the WSQ areas. As remedial activities begin to disturb source areas, the potential for increased airborne emissions will increase. More intensive work-area monitoring will maintain knowledge of real-time airborne emission levels.

Airborne particulates, radionuclides, and atmospheric radiation released from the WSS source areas must pass the facility boundaries before migrating to uncontrolled or public access areas. Site perimeter monitoring will be utilized to detect and monitor the migration of radioactivity detectable at the facility boundaries. Finally, specific locations around the WSS where there is concentrated human activity are considered "critical receptor" locations and receive focussed attention.

2.2.4 Soil and Sediment

Soils and sediments on and around the WSS have been, and in some locations continue to be, receiving contaminants from the WSS. The soil is generally in a stable condition and, although it might act as a long term source for groundwater contamination, soil in itself does not pose a dynamic contaminant front that would require routine monitoring. Soils and associated contamination that are disturbed during remedial activities may be mobilized by surface water runoff or dispersed in the air and migrate from the site. Therefore, the surface water monitoring program will monitor levels of suspended and settleable solids to assess the quantities of materials leaving the site; the air monitoring program, combined with air modeling when appropriate, will assess potential impact to off-site receptors.

For the purposes of this plan, sediments are those solid materials that are mobilized by fluid flow and accumulate to some discernable depth in and along the stream channels. Sediments have been characterized during the remedial investigations performed at the WSS and WSQ. That characterization, along with the determinations made during subsequent, routine biological and surface water sampling will meet the environmental monitoring data needs of the project for 1992.

2.2.5 Biological Media

Biological factors such as the animal and plant vectors in a biouptake chain will be sampled to assemble and maintain knowledge of the environmental and potential human impacts of the waste sources and to assess the effectiveness of the clean-up actions as they progress.

3 SURFACE WATER SURVEILLANCE PROGRAM

Surface water samples will be collected from locations known to be or potentially impacted by the Weldon Spring Chemical Plant/Weldon Spring raffinate pits (WSCP/WSRP) area and the Weldon Spring Quarry (WSQ). Because of the differing topography and hydrologic conditions at the WSCP/WSRP and WSQ, surface water sampling programs for each of the areas of the WSS are described separately. In previous environmental monitoring plans (EMP) for the Weldon Spring Site Remedial Action Project (WSSRAP) the monitoring of springs was included as part of the surface water monitoring program. The WSSRAP has changed this approach to incorporate spring monitoring under the groundwater monitoring program, consistent with the draft U.S. Environmental Protection Agency (EPA) guidance on groundwater monitoring in karst terrains. The data on contaminants in spring water will be more directly correlated to levels in the groundwater near the site as measured using conventional monitoring well techniques. Therefore, spring monitoring is no longer discussed in the surface water monitoring program section.

3.1 Surface Water Evaluation

Surface water bodies in and around the WSS and WSQ have been radiologically and chemically characterized through sampling and analyses. A surveillance program that includes monitoring potentially impacted surface water has been established to monitor radiological and chemical conditions. The extent of the surface water environmental surveillance program is based upon applicable regulations, hazard potential of effluents, quantities and concentrations of effluents, public interest, and the nature of potential or actual impacts on surface water. The environmental surveillance program for surface water will be conducted in accordance with the requirements of DOE Orders 5400.1, 5400.5 and the *Regulatory Guide*.

3.2 Surface Water Monitoring Program at the WSCP/WSRP

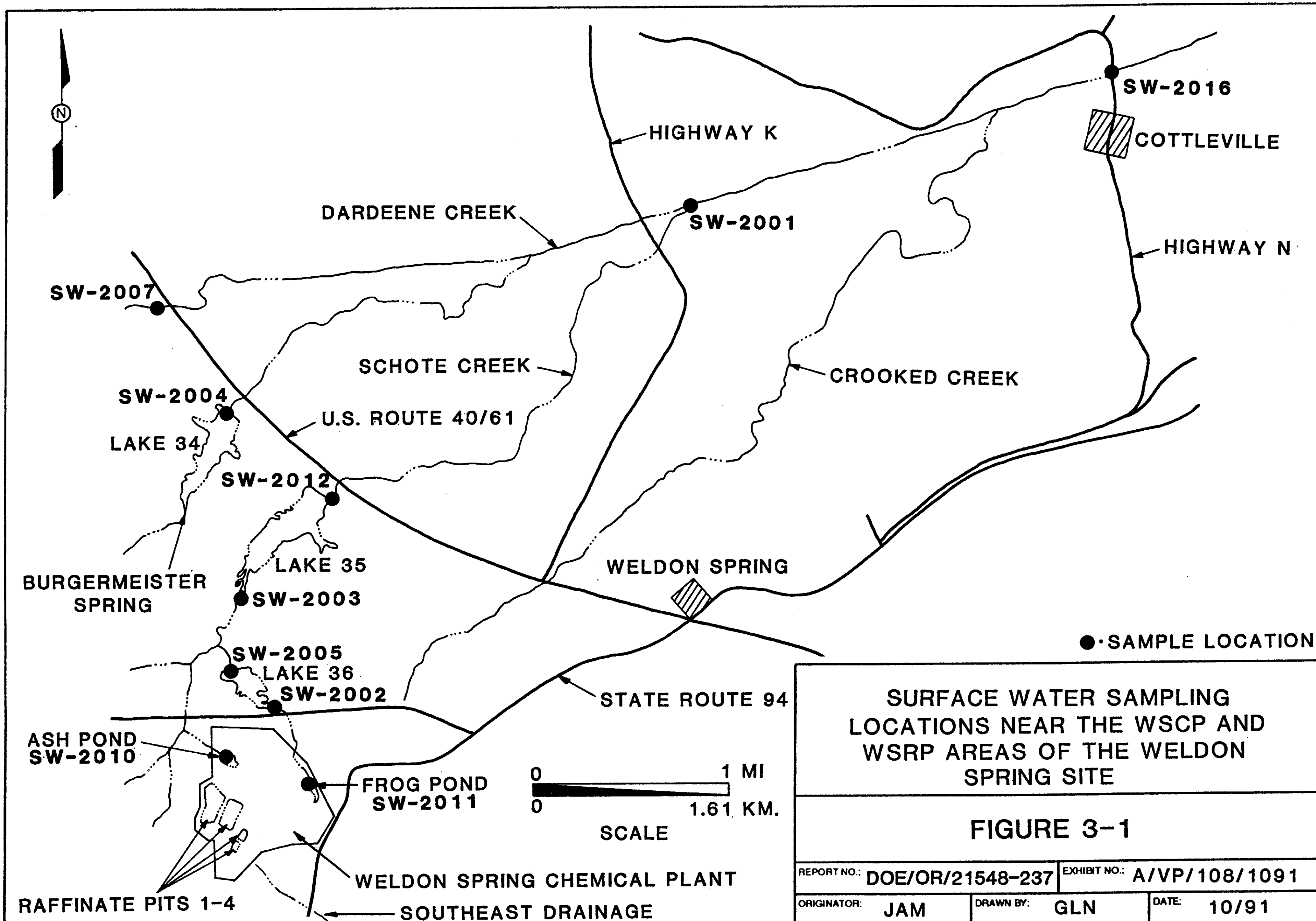
The WSCP/WSRP area is located on the Missouri-Mississippi River surface-drainage divide. The topography of the WSCP/WSRP is gently undulating and generally slopes northward to the Mississippi River. Streams do not cross the properties, but incipient drainageways convey surface water runoff to off-site streams. Most surface drainage from the WSCP area discharges either via an intermittent stream in the Army Reserve Training Area to the west or into Ash Pond on the WSCP property as shown in Figure 3-1. Discharges from the intermittent stream and Ash Pond combine near St. Charles County Road D and flow northward into Schote Creek, which in turn enters Dardenne Creek, which discharges into the Mississippi River. An additional surface drainage system ultimately reaching the Mississippi River drains the northeastern WSCP area through Frog Pond. A storm water sewer system that drains land surfaces from most of the plant area also discharges into Frog Pond. The Frog Pond drainage enters Lake 36 on the Busch Wildlife Area. Lake 36 in turn discharges into Lake 35 which ultimately discharges into Schote Creek.

Drainage from the southern portion of the WSCP property flows southeast to the Missouri River. Runoff originates from two sources. The first is the WSCP sanitary and process sewer system which merges prior to discharge from the WSCP. The sanitary sewer system was taken out of service in 1986, but receives some leakage from the storm water runoff system. The second source is surface runoff from the southern portion of the site.

Surface water which drains from the WSCP/RP area transports both dissolved and suspended element contaminants from waste materials distributed about the site. The locations chosen for monitoring of the surface water were chosen in order to provide the necessary data to track the fate and concentration of the contaminants to downgradient receiving streams and water features. The locations of the monitoring points and the rationale behind each location is described in detail in the following sections. The DOE has a firm understanding of the complex hydrogeologic system that influences the flow of surface water from the site to both the Missouri and Mississippi rivers. This understanding has come about through the cooperative efforts of the DOE with the Missouri and United States Geological Surveys.

3.2.1 Surface Water Monitoring Locations at the WSCP/WSRP

All surface water features monitored under the surface water surveillance program are situated on the north (Mississippi River) side of the drainage divide. Those waters requiring contaminant monitoring to the south of the surface divide are monitored under either the effluent monitoring or groundwater monitoring programs. The routine monitoring locations are numbered sequentially from SW-2001 through SW-2012 and SW-2016. Location numbers SW-2013, SW-2014 and SW-2015 were previously assigned to discrete temporary locations, which are not part of the 1992 routine monitoring program. Location SW-2016 is a new location added in this 1992 monitoring program and its function will be described in the following paragraphs in context with the entire sampling scheme.



SURFACE WATER SAMPLING LOCATIONS NEAR THE WSCP AND WSRP AREAS OF THE WELDON SPRING SITE

FIGURE 3-1

REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/VP/108/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91	

As shown on Figure 3-1, the sampling locations are distributed over surface water features at the down-gradient of the on-site contaminated water sources. Again, the program is designed to monitor the levels in the lakes and streams which pass through public and private lands in order to enable the DOE to assess the potential risk to down-gradient recipients. It also serves to document that the contaminant levels in the surface water diminish to background levels through dilution and other natural processes.

In previous monitoring years location SW-2001 at the confluence of Schote and Dardenne Creeks has been sampled as the furthest downstream location at which to measure the contaminant levels in Dardenne Creek after receiving the Schote Creek contribution. Location SW-2016 at the intersection of Dardenne Creek and County Highway N will now serve that function and was added because a report by the USGS noted that above background levels of uranium were measurable at that location.

Location SW-2007 is positioned on Dardenne Creek upstream of any tributaries that receive WSS contaminants in the runoff or groundwater discharge. This location serves as a background station for the determination of background contaminant levels prior to influence by the WSS discharge. Locations SW-2002 through SW-2006 and SW-2012 monitor the three lakes on the Busch Memorial Wildlife Area which lay within the receiving basin of WSS runoff. Location SW-2012 is positioned at the spillway of Lake 35. This lake leaks from its base and drains to Lake 34, among other places. Consequently, Lake 35 discharges only occasionally and monitoring of that discharge will be episodic with precipitation runoff.

The use of location SW-2006 (Busch Lake 10) has been discontinued since three years of data indicated no influence by the WSS and there is no visual or historical evidence of surface or subsurface impact. Locations SW-2008 and SW-2009 (Burgermeister Spring and Overflow Spring) continue to be monitored, but the location identifiers have been changed and monitoring is performed under the groundwater/spring monitoring program. Finally, locations SW-2010 and SW-2011 are at Ash Pond and Frog Pond within the boundary of the WSCP/RP area, and are monitored as the two major on-site surface water source features.

The raffinate pits located at the WSS are four solids-settling ponds utilized during plant operation to collect the waste products of the uranium purification and allow the decant water to discharge free of solids. The four pits vary in size; two are approximately 1 acre and contain approximately 12 ft of sludge material; Pit 3 is 9 acres in area and contains 12 ft to 14 ft of sludge material; and Pit 4 is approximately 13 acres in area but contains only a minor amount of sludge along with some waste scrap steel and drummed wastes from the decommissioning of the plant. Although the overflow system of the pits has long been discontinued and no direct runoff from the pits is presently possible, the pits contain surface water on top of the sludge material. The WSSRAP monitors this water to maintain a database on its quality and documents notable changes. These locations are numbered SW-3001 through SW-3004 for Pits 1 through 4 respectively.

As was stated previously, other surface water locations requiring water quality monitoring, e.g., the surface water discharge points at the site boundary, are included in separate monitoring programs such as the effluent monitoring and groundwater monitoring program.

3.2.2 WSCP/WSRP Surface Water Monitoring Schedule

Surface water features at the WSCP/RP area will be monitored according to the schedule listed on Table 3-1. Samples will be collected for uranium on a quarterly basis and for metals, certain radioisotopes, and inorganic anions annually to maintain a database on these substances. Quality assurance samples will also be collected per Table 3-1 in accordance with WSSRAP QA sample policy.

3.3 Surface Water Monitoring Program for the WSQ

The 13 surface water monitoring locations within or near the WSQ have been chosen for routine monitoring to investigate and document whether surface waters near the quarry might pose a risk to human health or the environment.

The WSQ is located on the northern bluff of the Missouri River valley. Surface water within the quarry consists of the quarry pond which acts as a sump and intercepts groundwater. There is no direct surface water runoff from the quarry; however, the movement of contaminated groundwater from the quarry through the fine-grained alluvium to the Femme Osage Slough has resulted in elevated uranium levels in the slough water. The quarry pond and the slough are directly impacted by the contamination within the quarry, therefore, they are routinely monitored. Also, samples from the Missouri River, the Femme Osage Creek, and the Little Femme Osage Creek are collected routinely to provide control data for comparison with data from those locations directly impacted by contamination from the quarry.

TABLE 3-1 Monitoring Parameters for Surface Water at the WSCP/RP

					QA SAMPLES			
Location	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
SW-2001	U	I,U,M	R*	U				
SW-2002	U	I,U,M	R*	U	D			
SW-2003	U	I,U,M	R*	U				
SW-2004	U	I,U,M	R*	U		B	A	
SW-2005	U	I,U,M	R*	U				
SW-2007	U	I,U,M	R*	U		D		
SW-2010	U	I,U,M	R*	U	A			
SW-2011	U	I,U,M	R*	U				
SW-2016	U	I,U,M	R*	U				
SW-2012**	U	I,U,M	R*	U				
SW-3001		R*,I		U		D		
SW-3002		R*,I		U				A
SW-3003		R*,I		U				
SW-3004		R,I		U				
SW-5311	R	R	R	R				

*	Isotopic analysis required	M	TCLP Metals plus Be, Tl, Sb.
U	Uranium	D	Primary laboratory duplicate
I	Inorganic anions	A	Secondary radiation duplicate
R	Radiological analysis including uranium radium and thorium	B	Secondary chemical duplicate
**	When flow is available		See Section 10 for discussion of QC data frequency

3.3.1 Monitoring Locations

Monitoring locations SW-1001 and SW-1002 (see Figure 4-3) monitor the Little Femme Osage Creek (which lies due west of the quarry) at points upstream and down stream of the WSQ. Six sampling locations--SW-1003 through SW-1005, SW-1007, SW-1009, and SW-1010--are distributed along the Femme Osage Slough west of, adjacent to, and east of the WSQ. These locations within the slough were chosen to provide the most representative data of potentially impacted areas from the quarry contamination. Location SW-1008, which monitors the ponded water within the WSQ, gives a rough determination of the concentrations of the various contaminants in the ponded surface water that may migrate to groundwater. Locations SW-1011, SW-1012, and SW-1013 (see Figure 3-2) were added to the monitoring program in 1989 to provide baseline water quality data from the Missouri River. SW-1011 is the Missouri River location furthest upstream above any potential influences from WSS contamination, while SW-1013 is furthest downstream below the outfall point of the southeast drainage easement. Location SW-1014, shown on Figure 3-2, was added to the monitoring program in 1991 to increase the coverage of water bodies potentially affected by the WSQ.

3.3.2 Monitoring Schedule

All surface water bodies near the WSQ that are used as baseline or are potentially affected by the WSQ, including the Femme Osage Slough, Femme Osage Creek, Little Femme Osage Creek, the Missouri River, and the quarry pond, will be sampled as shown in Table 3-2 at the locations shown in Figure 3-2.

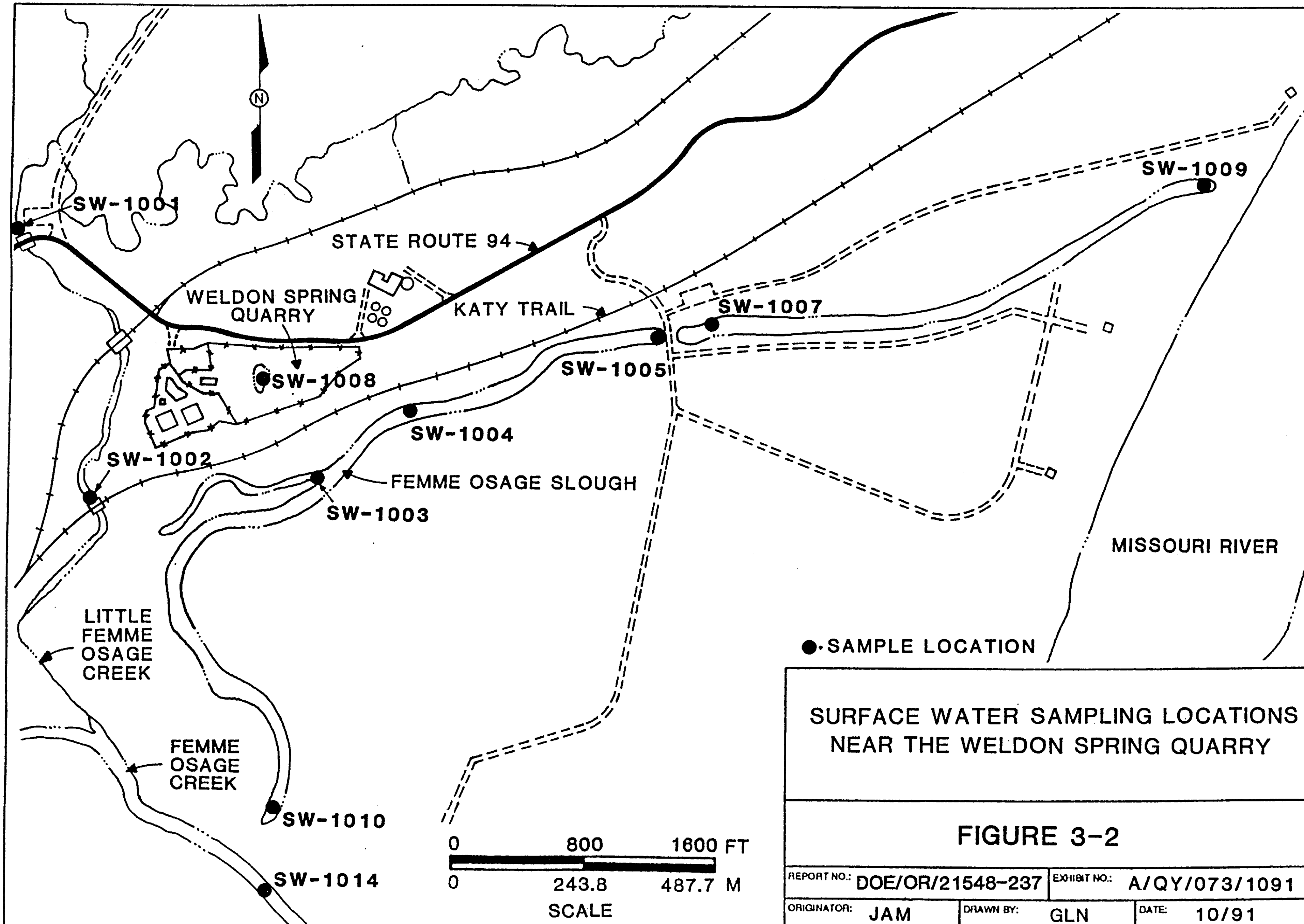
All locations will be monitored bimonthly, (once every two months), for uranium. This frequency will allow any trends to be identified in addition to maintaining a surveillance of uranium in surface water bodies near the WSQ. Additionally, all locations will be monitored at least annually for arsenic, barium, nitrate, sulfate, nitroaromatic compounds, and other radiological parameters, including Th-230, Th-232, Ra-226, Ra-228, gross alpha, and gross beta to provide baseline data and early detection of these parameters within surface water bodies near the WSQ. The quarry pond is monitored bimonthly for all parameters listed above, with the exception of arsenic and barium, to maintain surveillance of the contaminants within the quarry.

TABLE 3-2 WSQ Surface Water Monitoring Analytical Program for 1992

	1992 EMP						QA SAMPLES					
	JAN/ FEB	MAR/ APR	MAY/ JUNE	JULY/ AUG	SEPT/ OCT	NOV/ DEC	JAN/ FEB	MAR/ APR	MAY/ JUNE	JULY/ AUG	SEPT/ OCT	NOV/ DEC
WELDON SPRING QUARRY AREA												
SW-1001	U,M	R,N,I	U	U	U	U						
SW-1002	U,M	R,N,I	U	U	U	U			A		A	
SW-1003	U,M	R,N,I	U	U	U	U	D,B	A		A		
SW-1004	U,M	R,N,I	U	U	U	U						
SW-1005	U,M	R,N,I	U	U	U	U		D		D		
SW-1007	U,M	R,N,I	U	U	U	U						
SW-1008	R,I,N,M	R,N,I	R,N,I	R,N,I	R,N,I	R,N,I						
SW-1009	U,M	R,N,I	U	U	U	U		D,B				
SW-1010	U,M	R,N,I	U	U	U	U						
SW-1011	U,M	R,N,I	U	U	U	U		A		D		D
SW-1012	U,M	R,N,I	U	U	U	U						
SW-1013	U,M	R,N,I	U	U	U	U	A					
SW-1014	U,M	R,N,I	U	U	U	U			A,B		A,B	

R = Uranium, Ra-226, Ra-228, Th-230, Th-232, gross alpha and gross beta
U = Uranium
I = Nitrate, sulfate
N = Nitroaromatic compounds
M = Arsenic, barium

D = Primary laboratory duplicate
A = Secondary radiological laboratory duplicate
B = Secondary chemical laboratory duplicate
See Section 10 for discussion of QC data frequency



SURFACE WATER SAMPLING LOCATIONS NEAR THE WELDON SPRING QUARRY

FIGURE 3-2

REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/QY/073/1091
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91

4 GROUNDWATER SURVEILLANCE PROGRAM

4.1 Groundwater Evaluation

Groundwater within and around the Weldon Spring Chemical Plant/raffinate pits (WSCP/RP) and Weldon Spring Quarry (WSQ) has been radiologically and chemically characterized through sampling and analyses. A surveillance program that includes monitoring potentially impacted groundwater has been established to monitor radiological and chemical conditions. The extent of the groundwater environmental surveillance program has been determined based upon applicable regulations, hazard potential of effluents, quantities and concentrations of effluents, public interest, and the potential or actual impacts on groundwater. The environmental surveillance program for ground water will be conducted in accordance with the requirements of the U.S. Department of Energy (DOE) Orders 5400.1, 5400.5 and the *Regulatory Guide*.

4.1.1 Groundwater Characterization

Groundwater within or near the WSCP/RP and the WSQ was sampled to determine potential exposure pathways. Chemical and radiological characterization of the groundwater within or near the WSCP/RP and WSQ was provided through the implementation of work plans, sampling plans, and other characterization plans. These plans, which were approved by the DOE and the EPA, include environmental monitoring, sampling locations, procedures, equipment, frequency and analysis required, minimum detection levels and quality assurance and quality control components. The evaluation of the characterization data and potential exposure pathways has provided the basis for the environmental surveillance program for groundwater as described in the Groundwater Monitoring Program Section of this *Environmental Monitoring Plan*.

4.1.2 Groundwater Estimated Release Quantities and Public Doses

It is the objective of the groundwater monitoring program at both the WSCP/RP and WSQ to collect sufficient data to estimate the approximate quantity of radionuclides released along that migration route. The radionuclide release information will be used to calculate the public dose to hypothetical groundwater users. At present, no wells are actively pumped as water supplies within a 1 mi radius of the WSCP/RP site. Wells outside that area have been sampled in the past and have shown no evidence of radionuclide contamination from the Weldon Spring Site Remedial Action Project (WSSRAP). Those private wells will continued to be routinely sampled and analyzed by the Missouri Department of Health as part of an independent program by that agency. The results are also made available for review by WSSRAP staff.

The data collected from the WSQ and county wellfield region will allow a determination to be made on whether the WSQ presents an increased incremental risk to users of that water. No measurable increases in uranium levels above background at the wellfield have been seen to date.

4.2 Groundwater Monitoring Program for the WSQ

Forty-eight groundwater wells including 36 DOE monitoring wells, four St. Charles County monitoring wells, and eight municipal wells owned by St. Charles County have been chosen for routine monitoring to investigate and document the possibility that groundwater near the WSQ may pose a risk to human health or the environment.

4.2.1 Rationale

Chemical and radiological wastes at the quarry are of particular concern because of their proximity to the St. Charles County well field approximately 0.5 mi to the south. The issue of protection of the well field is one of great sensitivity to the public, the DOE, and other regulatory agencies. The DOE has issued a number of orders providing direction on the assessment of exposure to the public, including directions for protection from radiation and other chemical species where applicable. The monitoring strategy for and around the quarry has been developed to ensure the protection of public health and the environment.

Previous groundwater quality studies performed at the WSQ indicated several contaminants are present in or near the WSQ. Elevated uranium concentrations have been detected in the immediate WSQ area and in the alluvium north of the Femme Osage Slough. Elevated nitroaromatics, arsenic, barium, and inorganic anion concentrations have also been observed.

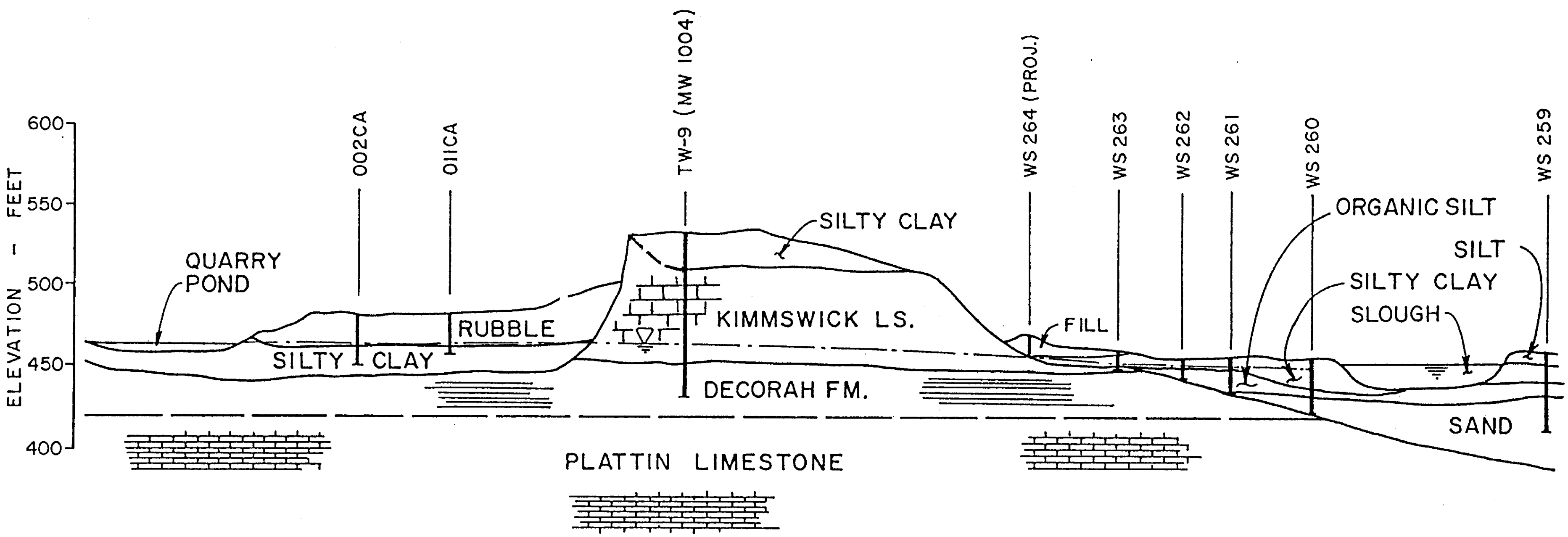
4.2.2 Monitoring Locations

The geology of the WSQ area is generally separated into upland overburden, Missouri River alluvium, and bedrock. The Missouri River alluvium and bedrock units produce groundwater and it is within these units that the groundwater is monitored. A general description of each unit follows and Figure 4-1 displays a generalized cross section of the quarry geology.

The unconsolidated upland material overlying bedrock consists of up to 30 ft of silty clay soil and loess deposits. A residual soil is present in some areas between the silty clay and the bedrock, however, the upland soils near the WSQ are generally not saturated and are not monitored.

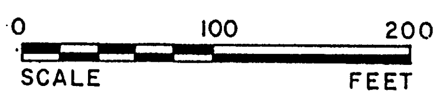
The sediments comprising the alluvium along the Missouri River vary from clays, silts, and sands, to gravels, cobbles, and boulders. The maximum alluvium thickness near the WSQ is approximately 100 ft. The alluvium is truncated at the erosional contact with Paleozoic bedrock bluffs along the now-abandoned Missouri, Kansas, and Texas (MK&T) railroad bed. The alluvium thickness increases dramatically with distance from the bluff. Silts and clays with minor amounts of sand are the primary sediments between the bluff and the Femme Osage Slough. The thick, water-producing sands and gravels of the alluvial aquifer give way to fine-grained organically rich overbank deposits beneath the Femme Osage Slough. The potentiometric surface of the alluvial aquifer fluctuates in response to pumping of the St. Charles County production wells and the stage of the Missouri River. This indicates that the Missouri River is the primary recharge source for the alluvial aquifer.

Currently there are 33 wells including eight municipal production wells, four county-owned monitoring wells, and 21 DOE-owned monitoring wells which are screened within the alluvial material located between the quarry and the Missouri River. Five of the wells, MW-1035 through MW-1039 (see Figure 4-2), are located west of the quarry to monitor the immediate area surrounding the quarry water treatment plant equalization basin and effluent ponds. Six wells, MW-1006 through MW-1009, MW-1014, and M-1016 are located between the quarry and the slough to monitor contaminant migration south of the quarry within the alluvium. The monitoring wells MW-1010, MW-1011, and MW-1017 through MW-1024 are located south of the slough within the alluvium and are monitored to enable detection of contaminants south of the slough. County monitoring wells RMW-1 through RMW-4 are



NOTE:

SEE FIGURE FOR LOCATION OF CROSS-SECTION.



GEOLOGIC CROSS-SECTION ACROSS QUARRY AND WELL FIELD AREA

FIGURE 4-1

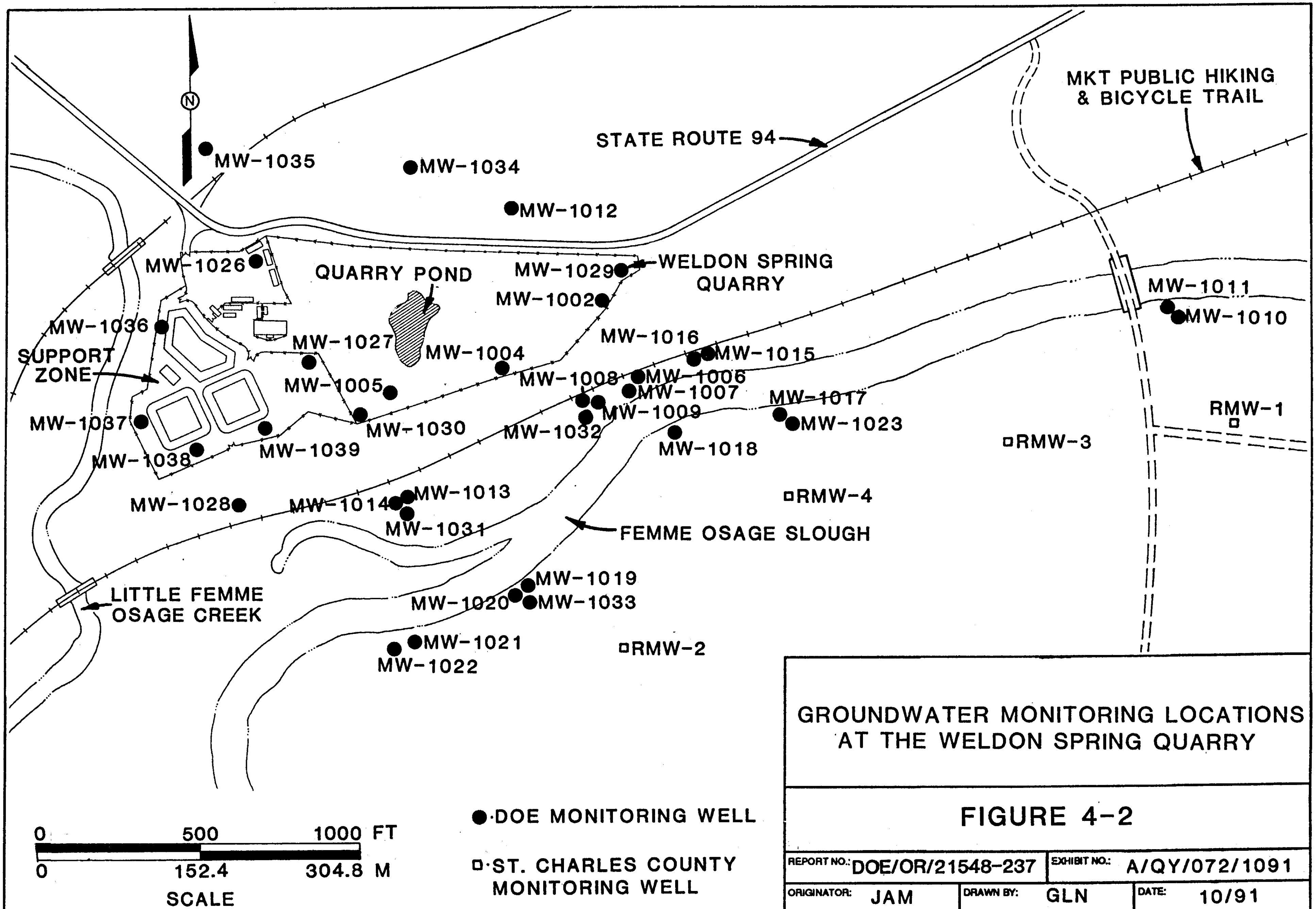
REPORT NO: DOE/OR/21548-237		DRAWING NO.: A/PI/190/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91	

monitored to (1) ensure that the quarry contaminants are not migrating toward the municipal wellfield, and (2) enable an early warning of contaminant migration toward the county production wellfield if this should occur. The eight county municipal wells, PW-2 through PW-9, are also monitored to ensure that the quarry contaminants are not affecting the quality of the municipal wellfield water supply. See Figures 4-2 and 4-3 for monitoring and production wells near the WSQ.

Bedrock at the WSQ consists of three distinct Ordovician formations. In descending order, they are the Kimmswick Limestone, limestone and shale of the Decorah Group, and the Plattin Limestone. The Kimmswick Limestone is a coarsely crystalline limestone with numerous solution-enlarged joints. The Decorah Group consists of interbedded limestone and green shale; it is approximately 30 ft thick, and is horizontally fractured. The Plattin Limestone is a thinly bedded limestone about 100 ft to 125 ft thick. Currently, there are 15 DOE owned monitoring wells which are screened within either the Kimmswick-Decorah or Plattin Formations to monitor contaminants near the quarry within the bedrock. Monitoring wells MW-1002, MW-1004, MW-1005, MW-1012, MW-1013, MW-1015, MW-1026, MW-1027, MW-1029, MW-1030, MW-1032, and MW-1034 were installed to monitor contaminants within the Kimmswick-Decorah Formation surrounding the quarry. It should be noted that MW-1012 and MW-1034 are north and upgradient of the quarry and have been designated as background wells. Monitoring wells MW-1028, MW-1031, and MW-1033 are located south of the quarry within the Plattin Limestone to determine whether vertical contaminant migration has occurred.

4.2.3 Monitoring Schedule

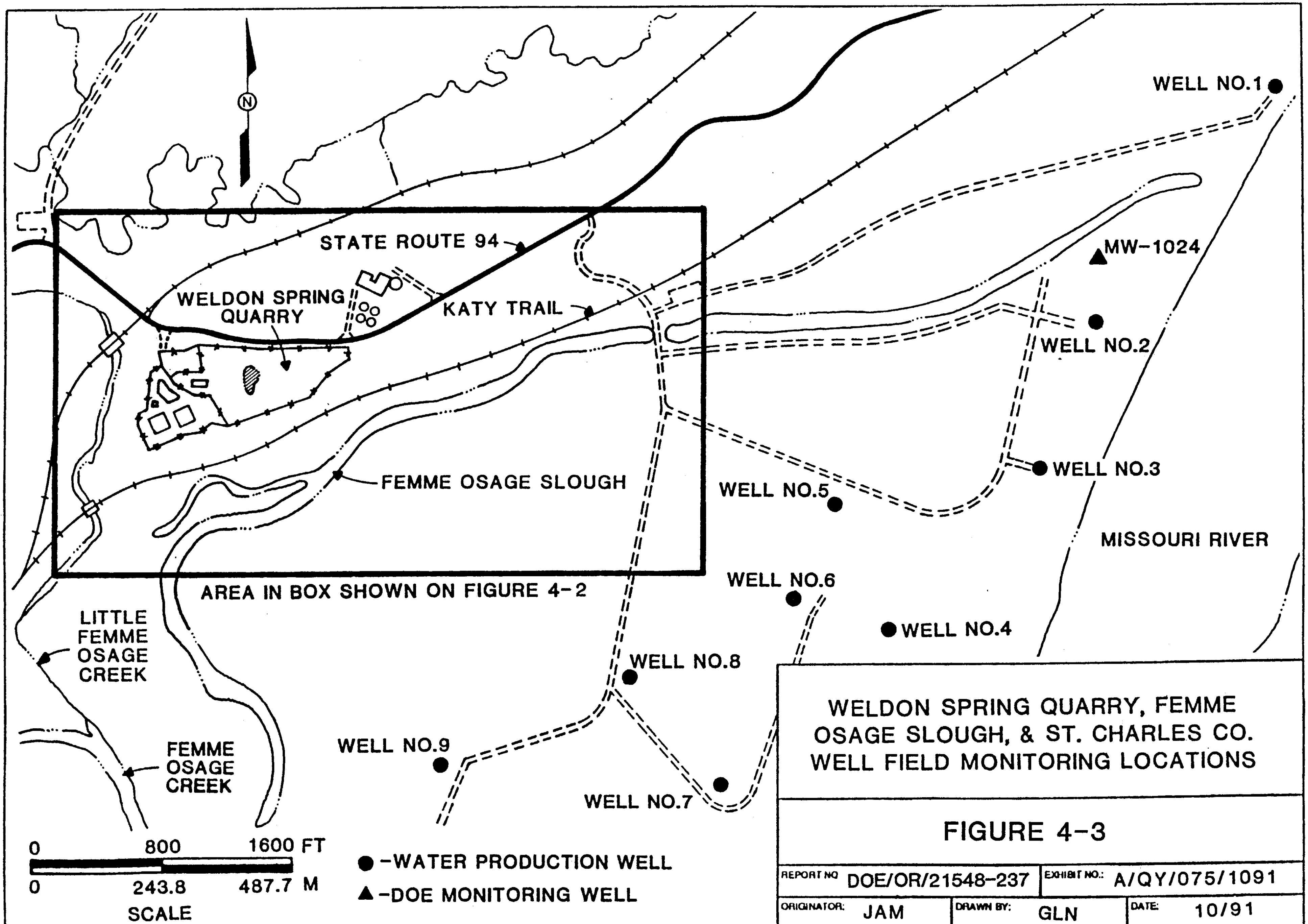
Two separate groundwater monitoring programs have been developed for the WSQ. The first program is a bimonthly sampling of all wells north of the Femme Osage Slough and also includes two wells, MW-1010 and MW-1011, south of the slough. These two wells were added to the bimonthly sampling because uranium levels above historical limits were detected for a short period during 1991 but returned to background levels by mid-year. This program is summarized in Table 4-1, and was developed to monitor contaminant migration and the effects of impoundment at the quarry water treatment plant scheduled to begin operation in the fall of 1991.



GROUNDWATER MONITORING LOCATIONS AT THE WELDON SPRING QUARRY

FIGURE 4-2

REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/QY/072/1091	
ORIGINATOR: JAM	DRAWN BY: GLN		DATE: 10/91



WELDON SPRING QUARRY, FEMME OSAGE SLOUGH, & ST. CHARLES CO. WELL FIELD MONITORING LOCATIONS

FIGURE 4-3

REPORT NO. DOE/OR/21548-237		EXHIBIT NO.: A/QY/075/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91	

TABLE 4-1 WSQ Groundwater Monitoring Program Summary

1992 EMP AND QA SAMPLES						
	JAN/FEB	MAR/APR	MAY/JUNE	JULY/AUG	SEPT/OCT	NOV/DEC
MW-1002	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1004	U,I,N,M	R,I,N,M	U,I,N,M-A,B	U,I,N,M	U,I,N,M	U,I,N,M
MW-1005	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1006	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-B	U,I,N,M
MW-1007	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-A	U,I,N,M
MW-1008	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1009	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1010	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1011	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1012	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1013	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-D	U,I,N,M
MW-1014	U,I,N,M-B	R,I,N,M	U,I,N,M-D	U,I,N,M	U,I,N,M	U,I,N,M-D
MW-1015	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1016	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1026	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-A,B
MW-1027	U,I,N,M-D	R,I,N,M-D,A,B	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1028	U,I,N,M-A	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,M,N
MW-1029	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-A	U,I,N,M
MW-1030	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-B	U,I,N,M
MW-1031	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M-D	U,I,N,M	U,I,N,M
MW-1032	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M-A,B	U,I,N,M	U,I,N,M
MW-1034	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-B
MW-1035	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1036	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1037	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M
MW-1038	U,I,N,M	R,I,N,M	U,I,N,M	U,I,N,M	U,I,N,M-B	U,I,N,M
MW-1039	U,I,N,M	R,I,N,M	U,I,N,M-D	U,I,N,M	U,I,N,M	U,I,N,M

R = Radiological - U, Th-230, Th-232, Ra-226, Ra-228, gross alpha and gross beta
M = Arsenic and barium
U = Uranium
I = Nitrate, sulfate
D = Primary laboratory duplicate
A = Secondary radiological laboratory duplicate
B = Secondary chemical laboratory duplicate
N = Nitroaromatic compounds
See Section 10 for discussion of QC data frequency

The second program monitors the area south of the Femme Osage Slough including the St. Charles County well field. Active production wells and select monitoring wells are sampled quarterly and annually. The raw and treated waters are also sampled. Table 4-2 presents the analytical parameters and sampling frequency of these wells. This portion of the WSQ groundwater monitoring program has been developed by representatives of the DOE, the Missouri Department of Natural Resources (MDNR), the Environmental Protection Agency (EPA), and St. Charles County.

The well field monitoring program includes sampling both untreated and treated water. Gross alpha analysis will be performed on the quarterly treated-water samples. This portion of the monitoring program satisfies the portion of the *Regulatory Guide* and DOE Order 5400.5 requiring the monitoring of affected or potentially affected public drinking water supplies as defined in 40 CFR Part 141.26. The quarterly gross alpha values will be averaged and presented in the *Annual Site Environmental Report*. All monitoring well locations are shown in Figures 4-2 and 4-3.

4.3 Groundwater Monitoring Programs for the Weldon Spring Chemical Plant/Raffinate Pit Area

The groundwater flow and contaminant transport mechanisms that make up the groundwater pathway are very different between the WSCP and the WSQ due to different geologic conditions. Groundwater monitoring at the chemical plant is conducted under two distinct monitoring programs. The first is the conventional application of monitoring wells at the site close to the contaminant source areas. The second is the monitoring of water from springs that represent the resurgence point for discrete flow paths receiving recharge in part from the site. The following sections describe the plans for both monitoring programs.

4.3.1 Geology and Hydrogeology

Geology at the WSCP and WSRP may be divided into two major units based on gross lithologic characterization: the unconsolidated glacial and residual soils, and the underlying bedrock.

The unconsolidated material consists of topsoil loess, glacially derived sediments, and residuum. Unconsolidated material to a depth of 20 ft to 50 ft is present at the WSCP/ WSRP.

TABLE 4-2 St. Charles County Well Field Sampling Program

MONITORING WELLS	ANNUAL SAMPLING PARAMETERS	QUARTERLY SAMPLING PARAMETERS
Well Number		
MW-1017	R	U,N,I,M
MW-1018	R	U,N,I,M
MW-1019	R	U,N,I,M
MW-1020	R	U,N,I,M
MW-1021	R	U,N,I,M
MW-1022	R	U,N,I,M
MW-1023	R	U,N,I,M
MW-1024	R,O,P	A,I,M,N,U
MW-1033	R	U,N,I,M,U
RMW-1	R,O,P	A,I,M,N,U
RMW-2	R,O,P	A,I,M,N,U
RMW-3	R,O,P	A,I,M,N,U
RMW-4	R,O,P	A,I,M,N,U
Pumping Wells		
PW-2	R,O,P,M1	A,N,U,M
PW-3	R,O,P,M1	A,N,U,M
PW-4	R,O,P,M1	A,N,U,M
PW-5	R,O,P,M1	A,N,U,M
PW-6	R,O,P,M1	A,N,U,M
PW-7	R,O,P,M1	A,N,U,M
PW-8	R,O,P,M1	A,N,U,M
PW-9	R,O,P,M1	A,N,U,M
RAW WATER	R,O,P,M1	A,N,U,M
TREATED WATER	R,O,P,M1	A,N,U,M

A = Gross alpha
I = Inorganic anions (nitrate, sulfate)
M = Metals - arsenic and barium
M1 = As, Ba, Hg, Pb, Cd, nitrate, sulfate
N = Nitroaromatic compounds
O = Organic, VOA and Semi-VOA
P = PCB, pesticides
R = Radiological - U, Th-230, Th-232, Ra-226, Ra-228, gross alpha and gross beta
U = Uranium, Natural
See Section 10 for discussion of QC data frequency

These glacial soils are generally silty clays with minor amounts of gravel. The unconsolidated materials are generally not saturated and therefore are not monitored.

Groundwater occurs in the bedrock underlying the WSCP/WSRP. The first bedrock unit encountered is the Burlington-Keokuk Limestone. The Burlington-Keokuk Limestone consists of two zones containing different lithologic characteristics: competent (unweathered), and weathered.

The shallow weathered Burlington-Keokuk Limestone is typically a grayish-orange to yellowish-gray, argillaceous limestone commonly containing as much as 60% chert nodules and interbeds. The weathered limestone is a low-yield, semi-confined, heterogeneous, anisotropic aquifer that is fractured and susceptible to natural solution processes. At the site, the aquifer generally exhibits diffuse flow properties overlain by discrete flow zones such as saturated highly weathered bedrock and saturated residuum in paleochannels.

The fracture flow, solution-effected discrete flow, and conduit flow are most effectively monitored by sampling springs at the resurgence points for that flow (Quinlan 1989).

The competent (unweathered) portion of the Burlington-Keokuk Limestone is thinly to massively bedded, gray to light gray, finely to coarsely crystalline, stylolitic, and fossiliferous. The fracture densities are significantly lower in the competent limestone than in the weathered limestone.

4.3.2 Groundwater Monitoring Program for the WSCP/WSRP

Groundwater monitoring is required by DOE 5400.1 to determine and document the effects of DOE operations on groundwater quality and quantity, and to demonstrate compliance with applicable Federal and State laws and regulations. Groundwater monitoring has been conducted at the WSCP/WSRP since the first quarter of 1987. The program has been adjusted yearly according to changes in laws and regulations, specific project needs, and Comprehensive Environmental Response, Compensation and Liability Act-National Environmental Policy Act (CERCLA-NEPA) requirements.

4.3.3 Rationale

Groundwater monitoring in the immature karst present at the WSCP/WSRP requires a two-pronged approach of monitoring wells and spring sampling. This stems from the fact that immature karst terrains have not developed a system of convergent conduit-dominated flow, but reflect components of both discrete and diffuse Darcian flow.

The groundwater monitoring program at the WSRP/WSCP has been modified from the 1991 Environmental Monitoring Plan (EMP) in order to provide the data necessary to:

- Ensure protection of public health and the environment.

- Develop a baseline for studying long term and short term effects of source removal to be conducted as part of CERCLA-NEPA activities slated for 1993-1994. At least one year of baseline data taken quarterly will be necessary in 1992 to provide adequate information for future comparisons.

- Develop a baseline for studying the effects of the settling ponds associated with the wastewater treatment plant.

- Perform spatial and temporal trend analyses.

- Provide information to support the groundwater separate operable unit (GWSOU) activity planning slated to begin in fiscal 1993.

The 4000 series wells will be monitored more frequently in 1992 than in 1991 to monitor contamination migrating off site. The density of the yearly data needs to be increased to determine trends and effectively monitor the surrounding environment.

Specific on-site wells will also be monitored more frequently than in 1991. Historical data has indicated increasing concentrations in these wells over time. More frequent sampling will provide information to analyze temporal and seasonal trends associated with these wells.

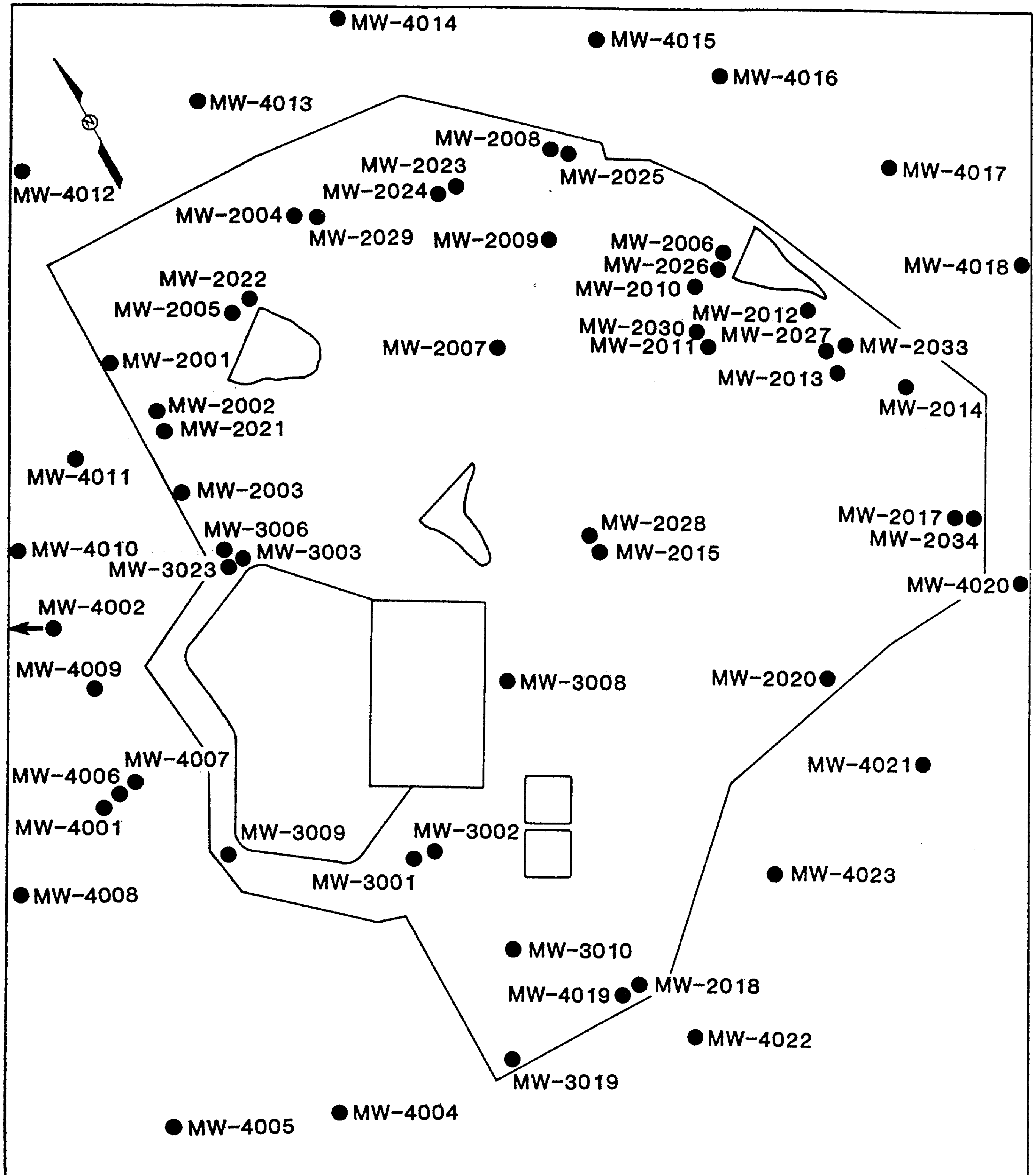
Frequent monitoring of a larger constituent list is necessary at specific wells to perform accurate spatial and temporal statistical comparisons. Greater frequency of data points is necessary to perform meaningful statistical analyses.

4.3.4 WSCP/RP Groundwater Monitoring Location

The number of monitoring wells in the 1992 sampling program will increase at the WSCP/WSRP. Additional monitoring wells will be installed in 1992 to obtain additional baseline information before contaminant source removal begins. Water quality of new and existing wells surrounding the source location will be monitored closely to analyze the short and long term effects of source removal. New wells will also be installed in 1992 according to Resource Conservation Recovery Act (RCRA) regulations to monitor the new water treatment plant. Monitoring well locations are shown in Figure 4-4. All monitoring wells are completed in the Burlington-Keokuk Limestone and are constructed of stainless steel or polyvinyl chloride (PVC). Monitoring wells are installed and developed in accordance with accepted procedure as discussed in the U.S. Environmental Protection Agency Resource Conservation and Recovery Act (RCRA), *Technical Enforcement Guidance Document* (EPA 1986) and Missouri State regulations, *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells* (EPA 1989) and the *Groundwater Protection Program Management Plan* (GWPPMP) (MKF and JEG 1991b). Fifty-eight of these wells monitor the upper portion of the formation. Eight wells monitor deeper portions of the bedrock aquifer, especially near potential source areas and in areas of known groundwater contamination. By monitoring these locations and depths, changes in the horizontal and vertical components of contaminant migration can be detected.

4.3.5 Monitoring Schedule

Quarterly sampling will be conducted at the perimeter 4000 series wells and key interior wells. The remaining interior wells will be sampled on a semiannual basis. The quarterly and semiannual samples will be analyzed for the same constituents that have historically been detected in the groundwater. In addition, for precautionary reasons, each well on site will be sampled and analyzed once per year for a suite of radionuclides that are present in the raffinate pit sludge. Analyses for volatile and semivolatile organic compounds, PCBs, and pesticides



● · DOE MONITORING WELL

● MW-4003

0 500 1000 FT

0 152.4 304.8 M

SCALE

WELDON SPRING SITE GROUNDWATER MONITORING WELL NETWORK

FIGURE 4-4

REPORT NO.: DOE/OR/21548-237	EXHIBIT NO. A/CP/156/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91

were performed once and not detected in the groundwater (MKF and JEG 1988c). These data, along with historical records, indicates there is no need to continue monitoring those parameters.

The specific wells, analytical constituents, and schedule for the quarterly and semi-annual sampling events are listed in Tables 4-3 and 4-4 respectively. Each well is identified and is followed by the coded summaries of the analyses to be completed during 1992. The coded summaries also identify the quality assurance duplicate samples that will be taken. The code letters for each sample are explained at the bottom of the table.

Using monitoring well 2013 (MW-2013) in Table 4-3 as an example, the letters U, I, N, and R in the First Half column indicate that the full set of analyses will be performed during that sampling event. The letter U indicates that the sample will be analyzed for uranium; the letter I indicates that the samples will be analyzed for nitrate, and sulfate (inorganic anions); and the letter N indicates that the sample will be analyzed for nitroaromatic compounds; and the letter R indicate that the sample will be analyzed for radium, thorium, and uranium isotopes. The remaining letters indicate the laboratories where duplicate samples will be sent. The letter D indicates that a set of duplicate samples will be collected and sent to the primary analytical laboratory.

Additional quality control samples will be collected to assess sample quality. These samples will include field blanks, distilled water blanks, and equipment blanks. The frequency of these samples will vary, depending upon the type of sampling equipment used. These samples will be collected to ensure that no contamination is introduced as a result of cross-contamination, field procedures, or shipping. Collection methods and utility are discussed in Section 10 - Quality Assurance.

4.3.6 Groundwater Monitoring at Springs

Due to the complex nature of the groundwater flow system beneath the WSS, involving both diffuse flow and discrete flow components, an adequate and complete groundwater monitoring program must involve both the use of conventional groundwater monitoring wells near the contaminant sources, and monitoring at springs to detect the transition of diffuse flow migration to the discrete (conduit) pathway. Springs in the vicinity of the site have been monitored since 1987 beginning with the DOE/Project Management Contractor (PMC) broad-based Phase I Spring and Seep characterization wherein some 30 springs and seep features were

TABLE 4-3 WSCP/WSRP Semi-Annual Groundwater Monitoring Analytical Program

	1992 EMP AND QA SAMPLES FIRST HALF	SECOND HALF
MW-2004	U,I,N,R	U,I,N
MW-2005	U,I,N,R	U,I,N
MW-2006	U,I,N,R-D	U,I,N
MW-2007	U,I,N,R	U,I,N
MW-2008	U,I,N,R-B	U,I,N
MW-2009	U,I,N,R	U,I,N-A,B
MW-2010	U,I,N,R	U,I,N
MW-2011	U,I,N,R	U,I,N
MW-2012	U,I,N,R	U,I,N
MW-2013	U,I,N,R-D	U,I,N
MW-2014	U,I,N,R	U,I,N
MW-2015	U,I,N,R	U,I,N-D
MW-2017	U,I,N,R	U,I,N
MW-2018	U,I,N,R	U,I,N
MW-2019	U,I,N,R-A,B	U,I,N
MW-2020	U,I,N,R	U,I,N-A
MW-2021	U,I,N,R	U,I,N
MW-2022	U,I,N,R	U,I,N
MW-2023	U,I,N,R	U,I,N
MW-2024	U,I,N,R	U,I,N
MW-2025	U,I,N,R	U,I,N
MW-2026	U,I,N,R	U,I,N
MW-2027	U,I,N,R	U,I,N
MW-2028	U,I,N,R	U,I,N
MW-2029	U,I,N,R	U,I,N
MW-2034	U,I,N,R	U,I,N
MW-3019	U,I,N,R	U,I,N

U = Natural Uranium, Total
I = Nitrate, Sulfate
N = Nitroaromatic Compounds
D = Primary Laboratory Duplicate
A = Secondary Radiological Laboratory Duplicate
B = Secondary Chemical Laboratory Duplicate
R = Radiological Parameters = Th-230, Ra-226, Pb-210, Po-210, Ac-227, Th-232, Ra-228, Th-228
See Section 10 for discussion of QC data frequency

TABLE 4-4 WSCP/WSRP Quarterly Groundwater Monitoring Analytical Program

	1992 EMP and QA Samples			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
MW-2001	U,R,I,N,G-A,B	U,N,I,G	U,I,N,G	U,I,N,G
MW-2002	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-2003	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-2030	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-2031	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-2032	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-2033	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-3003	U,R,I,N,G-D	U,N,I,G	U,I,N,G	U,I,N,G
MW-3006	U,R,I,N,G	U,N,I,G	U,I,N,G-D,A,B	U,I,N,G
MW-3008	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-3009	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-3023	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-4012	U,R,I,N,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-4013	U,R,I,N,G,G	U,N,I,G	U,I,N,G	U,I,N,G
MW-4001	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4002	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4003	U,R,I,N,G	U,I,N,G-B	U,I,N,G	U,I,N,G
MW-4004	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4005	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4006	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4007	U,R,I,N,G-B	U,I,N,G	U,I,N,G	U,I,N,G
MW-4008	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4009	U,R,I,N,G	U,I,N,G-A	U,I,N,G	U,I,N,G
MW-4010	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4011	U,R,I,N,G	U,I,N,G-B	U,I,N,G	U,I,N,G
MW-4014	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4015	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4016	U,R,I,N,G	U,I,N,G-D	U,I,N,G	U,I,N,G
MW-4017	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4018	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4019	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4020	U,R,I,N,G-D	U,I,N,G	U,I,N,G	U,I,N,G
MW-4021	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G
MW-4022	U,R,I,N,G-A	U,I,N,G	U,I,N,G	U,I,N,G
MW-4023	U,R,I,N,G	U,I,N,G	U,I,N,G	U,I,N,G

G = Geochemical Parameters = Nitrite, Chloride, Bromide, Fe, Mn, Ca, Mg, Na, K, Li, P, Ni, Ar, Ba, Sr, Cr, Si, Al, Pb, Ag Alkalinity and Dissolved Oxygen will be performed in the field.
U = Natural Uranium, Total
I = Nitrate, Sulfate
N = Nitroaromatic Compounds
D = Primary Laboratory Duplicate
A = Secondary Radiological Laboratory Duplicate
B = Secondary Chemical Laboratory Duplicate
R = Radiological Parameters = Th-230, Ra-226, Pb-210, Po-210, Ac-227, Th-232, Ra-228, Th-228
See Section 10 for discussion of QC data frequency

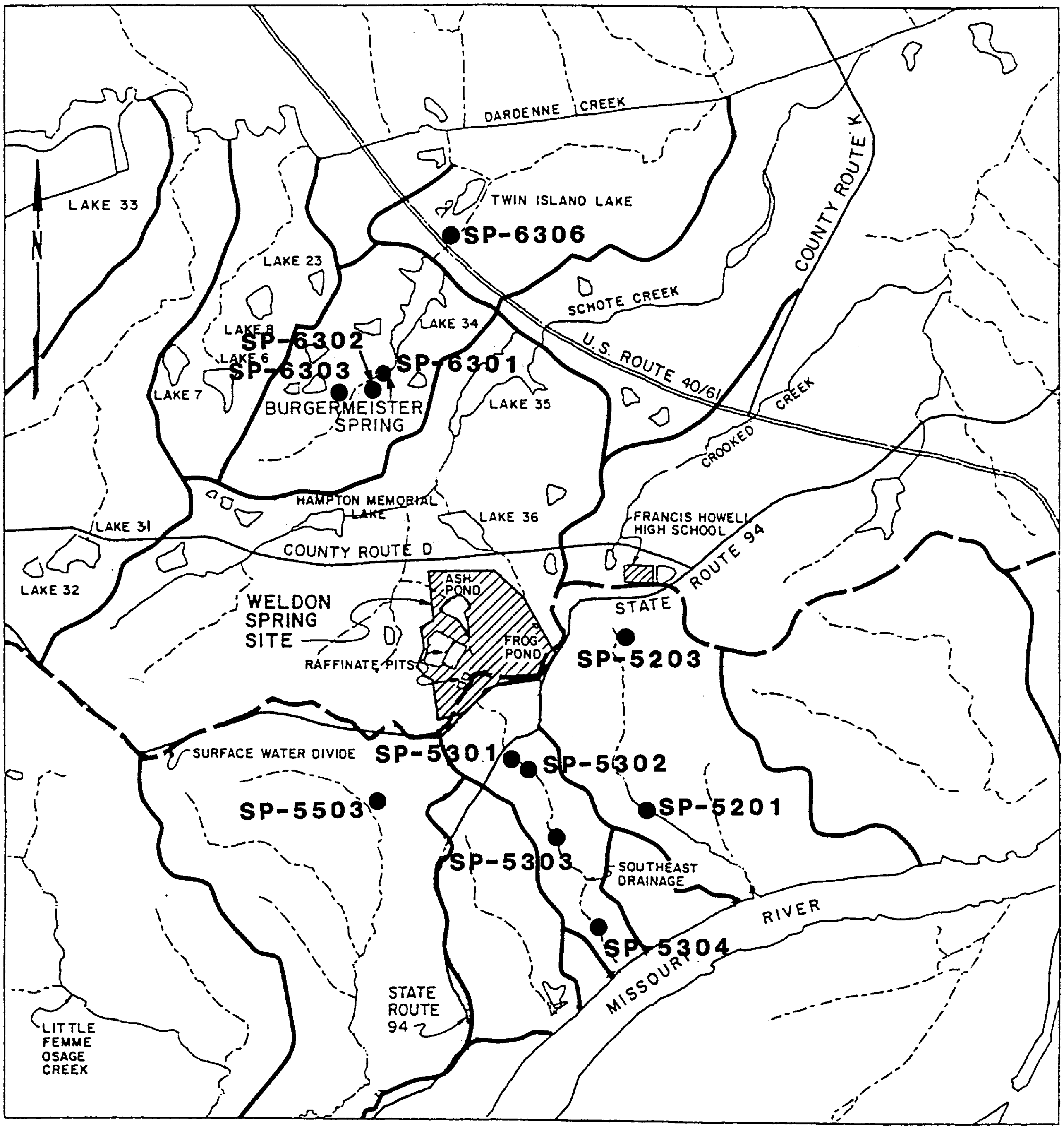
located within a 2-mi radius of the site. The springs were inventoried and sampled at varying flow rates. The set of springs impacted by the site was determined and a program of regular monitoring established around those springs. Through that program, and the additional studies conducted by the DOE, PMC, and State and U.S. Geological Surveys, the flow characteristics of the springs and their recharge basins were determined.

Phase I determined that a total of 11 springs, (nine perennial and two wet weather) were impacted or potentially impacted by site related contaminants. Each of these springs has been observed over time and their flow characteristics studied and recorded. Each spring has a unique recharge influence and response to varying recharge conditions. For this reason, the spring monitoring program described below will be of lesser or greater intensity than others in the program.

Following are the characteristics of the discrete flow mechanisms in action around the WSCP area. The rationale for monitoring and the particular structure of the individual monitoring programs are derived from these characteristics.

Regionally, the WSS resides on both groundwater and surface water divides. Waters that migrate from the site move toward the Mississippi River to the north of the divides and toward the Missouri River on the south side of the divides. This characteristic has allowed the WSSRAP to segregate the springs according to their respective geographic position within these basins. Although many springs were inventoried by both the DOE/PMC and the MDNR/DGLS, it was determined that springs located in only two major surface drainages were receiving contributions from contaminated water sources. Figure 4-5, shows the springs that have been routinely monitored for site-related contaminants.

Those drainages include Valley 5300 (southeast drainage), and Valley 6300 (Burgermeister Spring branch). The two source scenarios are quite different. The southeast drainage was used during operation of the Weldon Spring Uranium Feed Materials Plant as a discharge route for contaminated decant water from the sludge settling ponds. As a result of the imposition of contaminated water to the drainageway, the sediments have become contaminated by various substances including radionuclides. The natural springs along that drainage now discharge water containing uranium. Whether contamination at the Valley 5300 springs represents discharge of contaminated groundwater along conduit flow from an upstream source or the contamination comes from the sediments in the drainage itself, is not yet known.



●·SPRING

0 3200 6400 FT

0 975.4 1950.7 M

SCALE

SPRINGS IN THE VICINITY OF THE WSS

FIGURE 4-5

REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/VP/109/1091
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91

In the Burgermeister Spring branch, four springs receive site contaminants. The most prominent of the four, Spring 6301 (called Burgermeister Spring), is a perennial spring which receives both contaminated surface water runoff from the site and discharges contaminated groundwater at base flow conditions. Spring 6302 is an estuella or overflow point which discharges when the conduit capacity of the Burgermeister Spring is exceeded. Previous data indicate that the Burgermeister Spring and the overflow spring are effectively the same water discharging at two different points. Spring 6303 is a small perennial spring up-valley of the 6301/6302 set. Although too low and sporadic to draw final conclusions, the concentrations indicate at least occasional communication with uranium contaminated groundwater. The evidence thus far suggests that continued monitoring is warranted to (1) provide the data necessary to ensure environmental protection, and (2) provide additional information regarding the behavior of the conduit flow system.

Finally, Spring 6306, located below Busch Lake 34, is downstream of the previously described springs and evidence suggests it is derived in part from waters leaking from Lake 34. The presence of uranium in the waters at that spring may be due in part or entirely from the contaminated source waters of the lake. Other evidence suggests that a connection of leakage from Busch Lake 35 to that spring provides a second mechanism and source for the contaminated water at the spring.

4.3.6.1 Monitoring Program. Based upon what is known about the flow characteristics of the springs, the following program will be implemented to monitor the variations in contaminant levels in the site-effected springs. The monitoring program for 1992 will emphasize the flow rate from the springs at the time of sampling as a critical sampling component. Low flow is defined and intended hereafter to mean seasonal baseflow, or the stage of spring discharge when not influenced by active surface water runoff from the local land surfaces. Conversely, high flow is induced by precipitation events. The spring monitoring program will be implemented so as to sample spring waters at periods when they best represent the undiluted groundwater component of flow. To meet this criteria, springs will be sampled no sooner than a minimum of one week following the end of a precipitation event of sufficient intensity to cause surface runoff to occur. Planning and an extra level of scheduling flexibility will be required to implement this selective water sampling program.

Springs SP-5303 and SP-5304 will be monitored at low flow only, since the contributions from surface discharge to spring flow during high flow periods yield unrepresentative samples.

Spring 6301 (Burgermeister Spring) may accurately be described as the most critical point of contaminated groundwater resurgence associated with the WSS. Its discharge reflects the quality of both groundwater and surface water as they migrate from the areas impacted by WSS wastes. It follows that its quality, if characterized and monitored correctly throughout the site cleanup, should also reflect the improvements in environmental conditions. This "correct" monitoring will entail a close correlation of measured contaminant levels with the rate of discharge at the spring as well as the type of discharge event (baseflow, high groundwater level, or precipitation runoff) in progress at the time of sampling (Quinlan 1989).

Sampling of Spring 6302 (overflow spring) will be discontinued during 1992, since the historical data collected to date suggests that the waters which emanate at that spring when it flows are effectively the same as at Spring 6301. The continued collection of data from that location will no longer benefit the project.

The monitoring of Spring 6303 has shown that the spring is minimally impacted by WSS related contaminants. Continued monitoring of that spring provides data of limited usefulness since the cumulative impacts of contamination from that spring, and others in that drainage, are measured in the samples collected at Lake 34. Therefore, monitoring of Spring 6303 will also be discontinued for the 1992 monitoring year.

Spring 6306 has the potential to receive water from multiple sources including Busch Lakes 34 and 35. Although it is not believed that contaminant data from that spring will provide the DOE with any long term insight into the status of groundwater contamination or remedial effectiveness, the location of this spring, and the levels historically measured, warrant continued monitoring on a regular basis. This data will allow the DOE to make current, knowledgeable statements regarding its contamination status.

The data collected at wet-weather Spring 5503 suggest no impact by the WSS and it is appropriate at this time to discontinue monitoring that location.

Table 4-5 details the 1992 spring sampling program and schedule. In summary, springs that have historically been shown to receive contamination from the WSS, and whose measured contaminant levels continue to provide the DOE valuable environmental health and safety data,

Table 4-5 Groundwater Monitoring at Springs

	SCHEDULE			
LOCATION	Q1*	Q2**	Q3*	Q4*
SP-6301	L	H,L	L	H,L
SP-6306	L	H,L	L	H,L
SP-5303	L	L	L	L
SP-5304	L	L	L	L
SP-5201	L	L	L	L

* All samples analyzed for uranium, nitrate, and sulfate.

** Samples analyzed for full radiation (U, Th and Ra isotopes), nitrate, sulfate, and nitroaromatics.

L Low flow as defined in Section 4.3.6.1, para. 1

H High flow as defined in Section 4.3.6.1, para. 1

will be monitored more intensely. Those springs which have been shown to be minimally impacted or whose contaminant levels can be measured at other routine sampling locations will be discontinued for 1992.

5 BIOLOGICAL MONITORING PROGRAM

U.S. Department of Energy (DOE) Orders 5400.1 and 5400.5 and the *Regulatory Guide* require the development of surveillance programs for ecological systems to protect the health of the public and the environment. Specifically, these orders designate that samples of air, water, soil, foodstuffs, biota, and other media be collected for assessment. Ecological risk assessments are also an integral part of the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) process for the remediation of hazardous waste sites. U.S. Environmental Protection Agency (EPA) and DOE guidance require ecological surveillance to summarize site impacts and to the assess the effectiveness of proposed remedial actions. Other Federal and State laws covered by DOE orders include the *Threatened and Endangered Species Act*, the *Clean Water Act* and the *Wetlands Protection Act*. Primarily, the goal of the biological monitoring program is to support CERCLA ecological risk assessments conducted as part of the Remedial Investigation/Feasibility Study (RI/FS) process and to comply with the National Environmental Policy Act (NEPA) requirements. Identifying the ecosystem around the Weldon Spring site (WSS), the fauna and/or flora potentially at risk, and the levels and extent of contaminates with the ecosystem is the basis of the ecological Environmental Monitoring Plan (EMP) program.

A comprehensive biological surveillance program (Table 5-1) consisting of aquatic and terrestrial studies will be conducted at the Weldon Spring site (WSS) in order to meet these requirements. The focus of studies will include both qualitative and quantitative assessments of the ecosystems. The studies will collect data to determine evidence of biotic contamination, and identify receptor populations and the effects on biotic migration pathways as presented in Section 2.0. Various sites will be surveyed to examine community structure and population dynamics and to provide information on flora and fauna of the area.

Previous characterization studies at the WSS have defined the source areas of contamination and the potential pathways of contaminant migration. A lake and stream investigation was conducted in 1988 and sediment and water samples were analyzed for metals, nitroaromatics, polychlorinated biphenyls (PCBs), volatiles, semi-volatiles and radiological compounds. Elevated levels of radionuclides were detected (MKF and JEG 1989); however, no other compounds were detected. Biotic investigation conducted from 1987 to 1990 have included sampling of fish and small mammals (MKF and JEG 1988; 1989). No PCBs were

TABLE 5-1 1992 Biological Surveillance Plan

LOCATIONS	AQUATIC MONITORING				TERRESTRIAL MONITORING					
	FISH	BENTHIC INVERTEBRATES	ZOOPLANKTON	VEGETATION	HERPTOFAUNA	WATERFOWL	MAMMALS	AGRICULTURAL	VEGETATION	AVIFAUNA
Raffinate Pits 1-4				A*, S	S	S				S
Ash Pond					S	S	A		S	S
Frog Pond		A	A	A	S	S	A		S	S
SE Drainage		A			S		A		S	S
Busch Lake 34	A	A	A							
Busch Lake 35	A	A	A							
Busch Lake 36	A	A	A							
Burgermeister Spring		A	A		S		A		S	S
Quarry Pond/Forest							A		S	S
Femme Osage Slough	A	A	A	A	S	S			S	S
Little Femme Osage Creek		A								
Missouri River				A					A	
WSCP North Dump							A		S	S
WSCP Old Field							A		S	S
Katy Trail							A		S	S
Schote Creek		A								
Busch Agricultural								A		

TABLE 5-1 1992 Biological Surveillance Plan (Continued) 012292

LOCATIONS	AQUATIC MONITORING				TERRESTRIAL MONITORING					
	FISH	BENTHIC INVERTEBRATES	ZOOPLANKTON	VEGETATION	HERPTOFAUNA	WATERFOWL	MAMMALS	AGRICULTURAL	VEGETATION	AVIFAUNA
Weldon Spring Agricultural								A		
BACKGROUND LOCATIONS										
Lake 33	A									
Lake 37	A									
Lake 26		A	S	A	S		A			
Little Femme Osage Creek Upstream		A	S				A			
Geoke Spring SP-5001		A	S				A			
WSWA yellow Trial							A		S	S
WSWA Field 1 & 5							A		S	S
Augusta Farm								A		
Marals Temp Clair					S			A		
Prairie Lake - WSWA					S	S	A			S

A = Analytical Sampling (see text in Section 5)
S = Environmental Survey

* = Raffinate Pit 4 only
See Section 10 for discussion of QC data frequency

detected in fish samples. Arsenic, iron, lead, and chromium were detected in these samples, but were not attributed to site contaminants due to their equal presence in fish samples in control lakes (MKF and JEG 1988). No radionuclides were detected in small mammal samples. The Aquatic Biological Screening Investigation (ABSI) conducted in 1991 sampled benthic invertebrate, zooplankton, sediment and surface water. Elevated levels of uranium in surface water and sediment were found. Zooplankton diversities were higher in the contaminated lakes which may be the result of fish stocking practices. A report summarizing this study is in draft. Waterfowl were sampled from Raffinate Pit 4 during 1990. Results showed detectable levels of radionuclides in organ and bone samples. No control samples or documentation of use of the pits by waterfowl were taken. These needs are addressed in the 1992 EMP.

The biological surveillance program for 1992 will investigate the uptake and effects of radionuclides in select populations of biota. Other chemical contaminants will be studied as detailed below, based upon results as documented by previous soil, sediment, and surface water studies. Community structure and diversity will also be examined to determine any ecological effects of site contaminants. The 1992 EMP program is comprehensive in that an overall evaluation of ecological systems at the WSSRAP has not been previously performed. Based upon results in 1992, the ecological EMP will be re-evaluated to include only those areas considered at risk, requiring additional study, or of specific concern. Data gathered under the EMP will be used to monitor and assess the migration of contaminants from the site, the risks and effects to biota, and will also be used to guide future remedial action alternatives.

5.1 Aquatic Monitoring

Twelve locations will be included in the aquatic habitat studies of the biological surveillance program. Six locations will be monitored at the Weldon Spring Chemical Plant (WSCP), including the four raffinate pits, Ash Pond and its drainage to the northwest, and Frog Pond and its drainage to the north. At the Weldon Spring Quarry (WSQ), the Femme Osage Slough located south of the quarry will be routinely monitored.

Other aquatic sampling locations in the surrounding area include: the southern fork of the Little Femme Osage Creek, the Missouri River near the WSQ water treatment plant outfall, Lakes 34, 35, 36, and Burgermeister Spring at the Busch Wildlife Area; Schote Creek and the southeast drainage upper and lower springs; and SP-5301 and SP-5304 as designated in

Section 4. In addition, various lakes and creeks will be monitored as part of the background sampling program.

Past characterization studies conducted for the site have shown that the primary concerns to aquatic resources are the sediments and surface waters of ponds, lakes, and drainages. Chemical and radiological contaminants of concern include uranium, thorium, radium, nitrate, sulfate, fluoride, metals, and nitroaromatics. The aquatic monitoring program is designed with consideration to presence, concentration, chemical and radiological behavior, and the potential of human and ecological risk associated with the contaminants.

5.1.1 Fish Sampling

In conjunction with the Missouri Department of Conservation (MDOC) fisheries programs, fish samples will be taken annually from Lake 34, 35, 36, and the Femme Osage Slough. Background samples will be taken from Busch Lakes 33 and 37 because these lakes demonstrated no surface or subsurface connection to the WSS along water flow paths, and they resemble the study lakes in size and dynamics. Adult and juvenile fish will be collected using the electrofishing technique in which fish are stunned with a low electrical current, dip-netted from the water, and placed in holding tanks prior to data collection. All fish collected during the study will be identified, measured (total length), and counted. In addition, a gross examination of each fish will be made to determine the incidence of external disease, parasites, or physical abnormalities.

Specific game species, i.e., bass, sunfish, crappie, and catfish will be collected for radiological analysis. Edible portion, whole fish, and organ samples will be analyzed for isotopic uranium. Previous investigations of lake water and sediments and analysis of metals, nitroaromatics, PCBs, semivolatiles and volatile organics, and radiological compounds have shown uranium to be the only radiological contaminant of concern. The slightly elevated levels of arsenic, lead, mercury, and chromium found in fish samples were not attributed to WSS contaminants.

Results from radiological analyses will be used to calculate the effective dose equivalent to humans based upon consumption of fish. Bioaccumulation factors will also be calculated to determine whether fish from contaminated lakes result in factors above normal background levels of radiation (NCRP 1985, Gilbert 1985).

5.1.2 Invertebrates

Benthic invertebrates and zooplankton are routinely used as indicators of water quality. In 1991 a characterization program called the Aquatic Biological Surveillance Investigation (ABSI) was initiated. Fourteen locations were sampled and included lakes, streams, and springs. All but one designated location in the ABSI will be sampled in 1992. Schote Creek will be sampled instead of the original location at the confluence of Dardenne and Schote creeks.

Lakes and ponds will be sampled for benthic invertebrates and zooplankton; creeks and drainages will be sampled for benthic invertebrates. Benthic samples have been taken twice annually during April and July. For each lake, four locations have been selected based upon depth and sediment type. A composite sample will be collected for each location from three separate grabs using a dredge type sampler. Zooplankton samples will be collected weekly from April to June using a plankton net. Vertical tows will be taken, starting at the deepest end of the lake, and an estimate of water flow made using a flow meter connected to the plankton net.

Streams and drainages will be sampled at three sites: the riffle zone, the immediate upstream pool, and the immediate downstream pool. Riffle samples will be taken and will be composited from three Surber samples. Each pool sample will consist of three dredge grabs. A qualitative sample will be taken at each stream and drainage location in order to collect a representative community of benthic invertebrates. All invertebrates collected will be identified by species and enumerated to determine population densities and species diversities.

Biomass samples of benthic invertebrates will also be collected and retained for analysis of total uranium. Three grab samples taken from each lake and stream area will be separated into sub-samples by family or genus or composited based on total mass of sample collected.

A variety of hydrological data will be collected to assist in the interpretation of the biological data. Temperature, dissolved oxygen, conductivity, pH, water clarity (Secchi disc), total suspended solids, total phosphorus and alkalinity will be measured. A measure of the productivity of the lakes and streams will be taken by analyzing water samples for chlorophyll. Sediment and water samples will be analyzed for total uranium and toxicity metals (As, Hg, Pb, Cd, Cr, Ba, Se, Ag, Zn).

Total density and diversity will be calculated for benthic invertebrates and zooplankton. Comparisons will be made to uncontaminated lakes to determine if contaminants are effecting the invertebrate community in the lakes, springs, and streams. Water and sediment data will also be correlated to population densities and diversities to determine what factors or contaminants directly influence populations.

5.1.3 Aquatic Vegetation

The aquatic habitats found in the WSCP area and the Femme Osage Slough are all man-made impoundments, but have been classified as wetlands on the National Wetlands Inventory Map (U.S. Fish and Wildlife Service 1984). Even though these ponds are chemically and radiologically contaminated, they are utilized by fauna for foraging, breeding, and resting. A primary mechanism of contaminant entry is root uptake of radionuclides by aquatic vegetation.

A vegetation survey will be conducted of wetland areas to document the species, density, and seasonal occurrence of plants growing in the ponds. A reconaissance survey was conducted in August of 1991, and a wetland survey will be conducted in May and August of 1992, to make the necessary quantative field measurements during dry and wet conditions. This information will be used to assess wetland status of the aquatic habitats under Federal wetland guidance (FICWD 1989).

Four areas will be sampled for bioaccumulation of radionuclides in aquatic vegetation. The basin of Frog Pond and Raffinate Pit 4 is densely populated with various rooted aquatic vegetation. The Femme Osage Slough contains various species such as cattails and arrowheads. Whole samples (stems, roots, and leaves) will be taken in the late summer from these locations and analyzed for total uranium. In addition, aquatic and terrestrial vegetation along the Missouri River will be analyzed for total uranium concentrations under the preoperational monitoring of the National Pollution Discharge Elimination System (NPDES) program (Section 8).

Concentrations of radionuclides in vegetation will be measured and compared to background locations. These results, along with water and sediment data, will be used to determine if toxic effects could be occurring. Primarily, vegetation in aquatic habitats will be analyzed to determine whether fauna feeding on this vegetation are potentially exposed to radionuclides above background levels.

5.1.4 Waterfowl

Aquatic habitats at the WSS attract waterfowl and shorebirds throughout the year including mallard, spotted sandpiper, Canada goose, and herons. Many species utilize the waters for foraging, shelter, rest, and nesting.

In 1991, a summer resident census was conducted to determine waterfowl use of the aquatic resources at the WSCP and Femme Osage Slough. The results of this survey are not currently available, but based upon documentation of extended residency, samples of waterfowl game species will be collected. Samples will be analyzed for uranium, thorium, and radium concentrations in bones, flesh, and internal organs.

This characterization program may require that additional samples be taken in 1992. If so, a summer census will be conducted and additional games species will be sampled to determine bio-uptake of radionuclides. In addition, samples will be solicited from local hunters to be used as study and background data.

A winter migratory census will be taken, starting in September of 1991, and will continue one week per month through April 1992, and again from September to December of 1992.

5.1.5 Other Aquatic Studies

The Blanding's turtle is a semi-aquatic species considered endangered in Missouri. Two recent sightings were recorded for the turtle in the Busch Wildlife Area immediately north of the WSS. In order to determine if this endangered species occupies the aquatic habitats within the chemical plant or quarry area, a herpetofauna survey will be conducted. In addition to the Blanding's turtle, other species of frogs and toads will be surveyed. NEPA also requires a threatened and endangered species prior to any construction of, or modification to, facilities due to remedial actions.

Herptofauna occurring in the area will be determined by habitat searches and roadside and wetland observations. Surveys will include overturning logs, debris, and rocks during vegetation surveys. Incidental sightings during other ecological programs will be documented as well. Individuals will be identified either visually at a distance, or captured using a dip net, then identified and released. Specific sampling locations will include the Femme Osage Slough, Raffinate pits 1 through 4, Ash Pond and Frog Pond and their drainages, and Burgermeister Spring and the southeast drainage. Sampling will be conducted in March for breeding frogs and toads, and in the early summer for the Blanding's turtle.

5.2 Terrestrial Habitats

The terrestrial community of the WSS area is diverse. The WSCP and WSQ are primarily old field or maintained grass habitats with remnant upland and slope forests. Much of the land immediately surrounding and adjacent to the WSS is state-owned wildlife area (ANL 1990). Habitats within these areas include old field, cultivated farmlands, upland slope, and bottomland forests.

The terrestrial community supports a wide variety of fauna including avian and mammal species. White-tailed deer, gray squirrels, and cottontail rabbits have been sighted within the chemical plant boundaries. Opossum, fox, and coyote roam within the Weldon Spring and Busch Wildlife areas. Many birds are summer residents in the area and many spring and fall migratory species utilize the field and forest habitats. Eastern screech and barred owls have been sighted along deciduous forests south of the chemical plant.

Specific terrestrial habitats will be surveyed and routinely monitored as part of the biological surveillance program. At the WSCP, these areas include the north dump area, the upland and riparian forests surrounding Ash Pond and Frog Pond and their drainages, and the old field habitat surrounding the raffinate pits. At the WSQ, these areas include the quarry floor, Femme Osage Slough, and the upland and bottomland forests, north and south of the Katy Trail. The riparian and upland areas along the southeast drainage, and forest along Burgermeister Spring will be also be included in the terrestrial survey programs.

Past characterization studies conducted for the site have shown that the primary concerns to terrestrial resources are the soils and vegetation in contaminated zones. Radiological contaminants of concern include uranium, thorium, and radium.

5.2.1 Vegetation

Terrestrial ecosystems are generally categorized according to the vegetation that dominates the plant community (EPA 1989). As a basis for terrestrial studies, a vegetation and habitat map will be developed that delineates terrestrial ecosystems. Aerial photographs will be used to construct maps that will detail drainages, plant associations, historic and current land use, and ecosystem patterns.

Vegetation surveys will be conducted in each study location to document the community structure. Descriptions and inventories of plant species occurring at each location will be conducted during spring and summer. Vegetation communities will be quantified using the stratified random sampling methods. Species presence, percent vegetative cover, and percent canopy cover will be obtained. Qualitative notes on species abundance, growth factor, and terrain slope will be documented. Above-ground plant conditions will be visually examined for discolorations, parasitic galls, and leaf necroses. Specific efforts will be made in searching suitable habitats for species listed as threatened or endangered by the Missouri Department of Conservation.

Data collected from vegetation studies will primary be used to document vegetative habitats, identify effected areas and/or potentially effected environments. In addition, habitats that support or have the potential to support species of special concern (threatened or endangered) will be noted.

5.2.2 Birds

Avifauna surveys will be conducted using observational census methods. Binoculars, spotting scopes, and vocalizations will be used to document species occurrence. Surveys will be conducted bimonthly at each primary location. At each location, a 15-min observation period will be made and species will be recorded according to visual or audio identification. Data recorded will include habitat type, weather, sex, behavior, and species. Data collected will be used to estimate species diversity, density, and habitat use. In addition, all active nests found during surveys will be documented.

Particular attention will be paid to the surveying of threatened and endangered species including the bald eagle and Cooper's hawk based upon terrestrial habitat preferences. In addition, areas particularly favored by large bird populations and/or migrating birds will be noted in support of ecological assessments for the site and quarry.

5.2.3 Mammals

Large and small mammal surveys will be completed in order to determine the species, communities, and use of land within the boundaries of the WSS and within surrounding wildlife areas. Particular attention will be given to game species such as the white-tailed deer and eastern cottontail which are known to frequent the chemical plant area.

For large mammals, observational surveys will be conducted weekly within the chemical plant area. Site-specific locations, activities, and species will be documented. Observations will include visual sightings, detection of tracks, scats, and nests.

Opportunities will be taken to sample large mammals due to road-kill, accidental death, or donated samples; these samples will be analyzed for total uranium concentrations. Only mammals utilizing the chemical plant and quarry locations and those taken as background samples will be considered.

Small mammals will be biannually sampled during winter and spring. Live traps will be baited and placed along transects at the north dump area, south dump area, Frog Pond drainage, southeast drainage, and area surrounding the Femme Osage Slough. Small mammal densities and communities will be determine by the trap and recapture sampling method. Traps will be set for four nights and all captured mammals will be tagged and released. Species, age, sex, tail length, right hind-foot length, and previous capture data will be determined for each capture.

Small mammals will also be collected for radiological analysis. Primarily, rodents will be taken including deer mice, voles, and shrews. Each specimen will be identified by species and sex. The length and live weight will be determined and each species will be examined externally for the presence of lesions, tumors, or other abnormalities and reproductive condition. Whole-body specimens will be analyzed for uranium, thorium, and radium concentrations.

Small mammals are being surveyed to determine what populations are potentially at risk, what levels of contaminants are being accumulated, and the potential for larger mammals and birds that prey upon these mammals to biomagnify these contaminants.

5.2.4 Agricultural Products

Agricultural lands surrounding the WSS comprise approximately 20% of the terrestrial habitat. The Busch Wildlife and the Weldon Spring Wildlife areas contain approximately 2,200 acres and are leased to sharecroppers for farming (MKF and JEG 1991f). Besides state-owned property, many private farms are located within the immediate area. Agricultural products grown in the area include corn, soybeans, sunflowers, and sorghum. These products are grown primarily for cattle and wildlife feed and forage.

The wellfield located adjacent to the Femme Osage Slough south of the WSQ is also activity farmed. Uranium concentration in the slough has ranged from a low of <1pCi/l to a high of 557 pCi/l, with an average around 54.8 pCi/l. In addition to the U.S. Department of Energy (DOE) requirement for monitoring of "foodstuffs", the public has expressed concern over the potential for elevated levels of radionuclides in the agricultural products.

According to the requirements of the *Regulatory Guide*, an 8-mi radius of agricultural lands surrounding the site will be surveyed for farm and gardening practices. Samples will be selected and analyzed for uranium, thorium, and radium. Samples will be taken based upon farming practices within the study area as provided by the county Soil Conservation Service and the Missouri Department of Conservation.

The number of samples (for each crop type) will be equal to 1% of the total number of acres planted within the study area (example: 2,000 acres of corn planted = 20 samples for corn). A minimum of four samples will be collected. Samples will also be taken with consideration for the distance from a contamination source, such as the quarry pond. Soil samples will be collected from each location in addition to foodstuff samples. Samples will be analyzed for uranium, thorium, and radium concentrations. Determinations will be made on the significance of radiological concentrations found in agricultural samples taken within an 8-mi radius of the WSS and those collected from background locations.

5.3 Background Sampling

Sampling of similar ecological habitats and fauna as those found within the Weldon Spring site will be conducted. These background samples are necessary in order to establish baseline environmental conditions that occur within the surrounding area. Areas that have no exposure pathway from the site, are in close proximity to the site, and that mirror ecological habitats in terms of water, chemistry, and topography. will be selected to serve as background sampling locations. Locations for aquatic studies include Busch Lakes 33, 37, and 26; the upstream branch of the Little Femme Osage Creek; Geoke Spring (SP-6501); and the upstream branch of Dardenne Creek. Locations for terrestrial studies include Marais Temps Clair Wildlife Area, Prairie Lake, Augusta Farm, Weldon Spring Wildlife Area (WSWA), Yellow Trail, and WSWA Agricultural Field 1 and 5.

Background sampling will be conducted for the 1992 *Environmental Monitoring Plan* (EMP) for all biouptake studies. These specifically include sampling for fish, benthic, invertebrates, zooplankton, agricultural products, aquatic vegetation, small mammals, and waterfowl.

5.4 Data Reporting

All information gathered from ecological survey and monitoring activities will be used to characterize the flora and fauna of the Weldon Spring site. Survey data will be summarized to indicate population densities, species presence, and species diversities. Estimates will be made on vegetative cover, faunal ranges, and usage patterns. A general overview of the ecological populations will be documented and used in determining significant receptor populations.

Data collected for biouptake studies will be used to determine exposures for human populations and for other animal populations. Dose calculations for humans based upon ingestion of contaminant biota will be performed as discussed in Section 9. Exposure indicators (bioaccumulation factors) and contaminate concentrations will be determined for biota. Behavioral indicators and habitat degradation or modification will be examined as part of the assessment. Contaminant concentrations will be compared to background concentration to determine evidence of biouptake. The statistical tests that will be used will determine whether selected biota utilizing contaminated resources have significantly higher levels of contaminant concentrations than background biota at a 90% confidence level. The student's T-test or the Mann-Whitney U-test will be used based upon whether the distribution of data populations can be assumed to be normal. Preliminary tests of variance and normality will be determined by using the W-test and F-test. For the W-test, data reported as non-detects or less than the detection limit (DL) will be quantified as DL/2 according to EPA guidance (1989).

5.5 Collection Permits

The taking of specific fauna for scientific study is authorized by permits from the Missouri Department of Conservation and the U.S. Fish and Wildlife Service. Applications for permits, as required by sampling plans and State and Federal regulations, will be submitted prior to sample collection. Compliance with all applicable State and local laws will also be followed in all ecological sampling programs designated here.

5.6 Natural Resource Trusteeship

The Project Management Contractor (PMC), under the authority of the DOE and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), acts as Natural Resource Trustees at the Weldon Spring Site Remedial Action Project (WSSRAP). Other agencies at the WSSRAP also act as Natural Resource Trustees. These include the U.S. Fish and Wildlife Service, the Missouri Department of Conservation and the Missouri Department of Natural Resources. The PMC coordinates with these agencies at the State and local level to notify them of releases of CERCLA hazardous substances. The biological monitoring program outlined here gathers the information necessary to provide an assessment of existing ecological conditions as required under the Natural Resource Trustee Act. In addition, the monitoring program provides a means to monitor unplanned releases and to assess the threat posed by a release. The results of annual monitoring as presented in the *Annual Site Environmental Report* are provided to these Federal agencies.

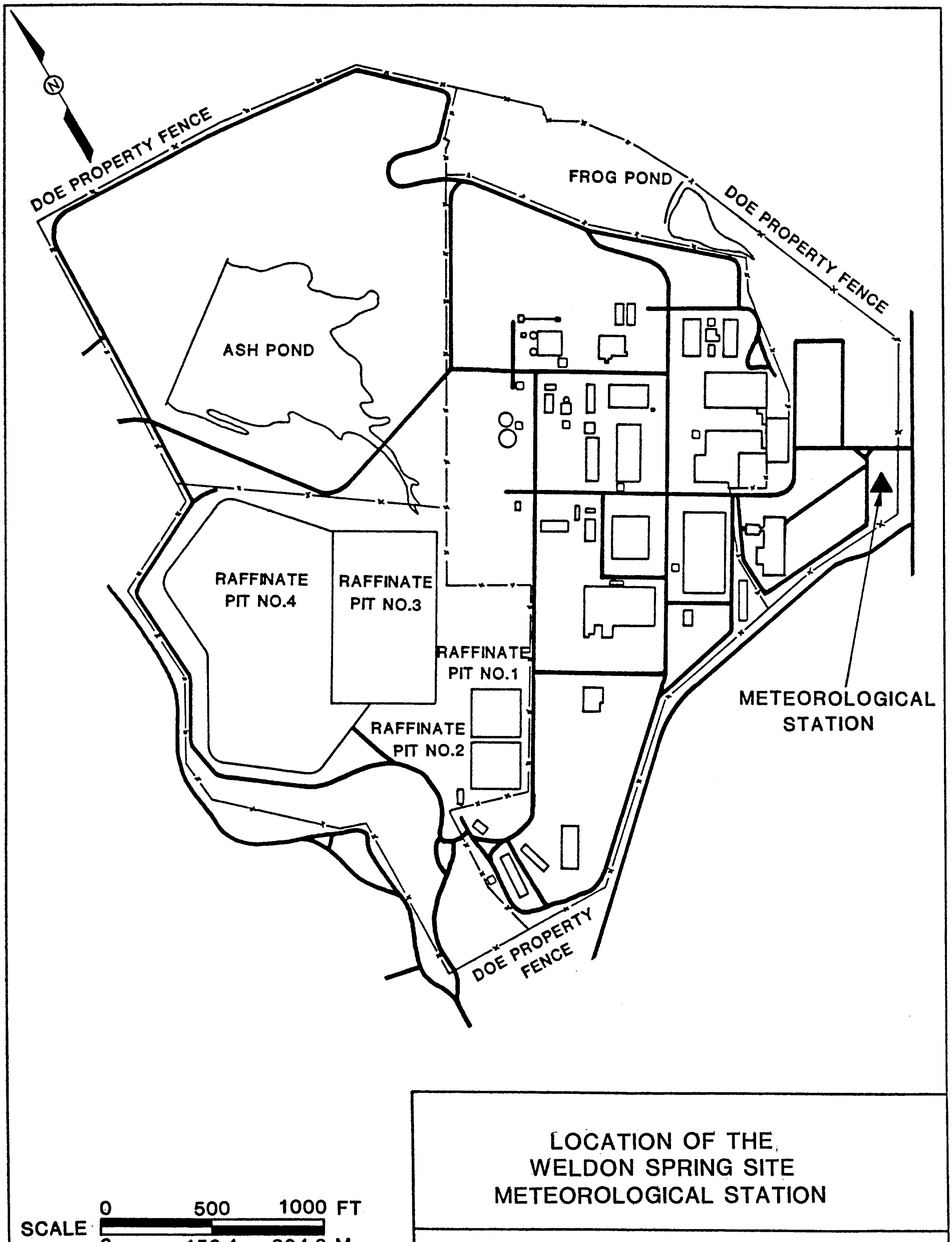
6 METEOROLOGICAL MONITORING PROGRAM

This section provides a description of the meteorological parameters measured, meteorological instrumentation, and computer programs and models that are utilized to support the environmental surveillance and emergency response activities at the Weldon Spring Site Remedial Action Project (WSSRAP). Radiological dose calculation to the general public is based upon measurements from critical receptor locations (Section 8.2.3). The use of actual concentration measurements at these locations yields more accurate dose calculations than those based upon modeling of downwind dispersion. The sources for off-site airborne releases that exist at the site are diffuse sources from waste areas and site remedial activities. No point source (stack-type) releases are in operation at the site.

The WSSRAP has two diffuse sources of airborne radiological emissions: the Weldon Spring Chemical Plant and Weldon Spring raffinate pits (WSCP/WSRP), and the Weldon Spring quarry (WSQ). An assessment of the two diffuse sources was conducted as required by the *Regulatory Guide*. The assessment included documenting the different radionuclides that could potentially be released from the sources and their concentrations.

The WSQ diffuse source is a 9-acre limestone quarry located approximately 2.4 mi south-southwest of the 217 acre WSCP/WSRP area. The WSQ is located 650 ft above sea level while the WSCP/WSRP is 500 ft above sea level. As determined by a certified meteorologist, the WSQ and the WSCP/WSRP meteorological conditions do not differ significantly and thus do not require separate meteorological monitoring stations. The location of the meteorological station is on the eastern edge of the WSCP/WSRP area more than 400 ft from the nearest building (Figure 6-1). Source term assessments are further discussed in Section 8.1.1 for the WSQ and in Section 8.1.2 for the WSCP/WSRP.

The meteorological station for the WSSRAP is designed to sample and record meteorological variables: wind speed, wind direction, horizontal wind fluctuation, ambient air temperature, barometric pressure, and precipitation intensity and accumulation. The station performs computations on the sampled signals and the data are stored electronically. Provision is also made to record the signals on a back up chart recorder located at the tower site. Data collected by the monitoring station will enable dispersion and diffusion modeling to supplement critical receptor monitoring in the event of an airborne release.



LOCATION OF THE WELDON SPRING SITE METEOROLOGICAL STATION

FIGURE 6-1

REPORT NO.:	DOE/OR/21548-193	EXHIBIT NO.:	A/CP/162/1191

ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	11/91

The meteorological station consists of a 10 m retractable, tilt-down tower with wind speed and direction sensors located at the 10 m level. Sensors at greater heights are not necessary since potential releases of airborne emissions are at or near ground level. The wind-aspirated temperature sensor is located on a post at the 2 m level and the precipitation gauge is located at ground level. The barometric pressure sensor is located inside an electronic enclosure situated adjacent to the tower. The horizontal wind fluctuation is computed by the station electronic circuitry. The aforementioned meteorological parameters are collected and stored as digital signals every 60 sec. Every hour, the one min recordings are averaged and stored as hourly data. This hourly data is then downloaded once per day to a remotely-located computer. The hourly data are then reviewed on a daily basis and archived onto floppy and hard drives.

These data are used to support the WSSRAP environmental surveillance program. Precipitation measurements will be correlated to aquifer water level fluctuations in the Femme Osage Slough and the WSQ. Water level fluctuations will be studied to aid in the determination of the cause of fluctuating uranium concentrations at the aforementioned locations. Wind direction results will be analyzed to determine if studies on foliar absorption by vegetation are needed. Radon and radon-daughter real time data will be coordinated with meteorological data at some future date.

Furthermore, the real-time data read out of meteorological variables aids site personnel in observing and analyzing the dispersion of potentially released airborne materials during and after an incident.

The computer program METDSPL is a qualitative atmospheric dispersion program designed to provide a schematic view of dispersion at the WSSRAP. This will aid the emergency response team in the event of a release. The plume depicted by METDSPL is based on an eulerian formulation. It simulates the path of a series of hypothetical gas particles released from a point source. The tracks of these particles are then plotted to scale on the computerized map of the site. METDSPL continuously polls the remote station for wind speed and wind direction values that are then updated on the screen, and a sector plot drawn. At the end of a segment time step, the vector averages over that interval are used to plot the distance and direction each segment moved during the period. The new paths and the background map are then redrawn.

Inspection and maintenance of the meteorological station, daily review of meteorological data, and semiannual calibration of the meteorological station are documented in Environmental Safety and Health procedures.

7 EXTERNAL RADIATION EXPOSURE ENVIRONMENTAL SURVEILLANCE MONITORING

The external radiation exposure environmental surveillance program at the Weldon Spring site (WSS) was designed to monitor potential external exposure points at the Weldon Spring Chemical Plant/Weldon Spring raffinate pits (WSCP/WSRP) and Weldon Spring Quarry (WSQ) perimeters, vicinity properties, and at off-site locations where the highest potential for an exposure to a member of the general public to gamma radiation exists. Gamma radiation is emitted by nearly all the radionuclides of the U-238 and Th-232 decay series. These radionuclides are found in above-background concentrations on the WSS, and as a result gamma radiation is monitored.

In addition, the environment contains naturally occurring radioactive substances which emit gamma radiation. Terrestrial radiation sources are natural radioactive elements in the environment (soil, water). Cosmic radiation is high-energy radiation that originates in outer space and filters through the atmosphere reaching the Earth's surface. Together, these two sources account for natural background gamma radiation. Terrestrial and cosmic radiation fluctuates depending on the soil composition and elevation above sea level.

The spherical environmental thermoluminescent dosimeters (TLD), which will be employed to monitor gamma radiation, are composed of five lithium fluoride chips in a durable spherical polyethylene holder. The TLDs will be collected and analyzed on a quarterly basis.

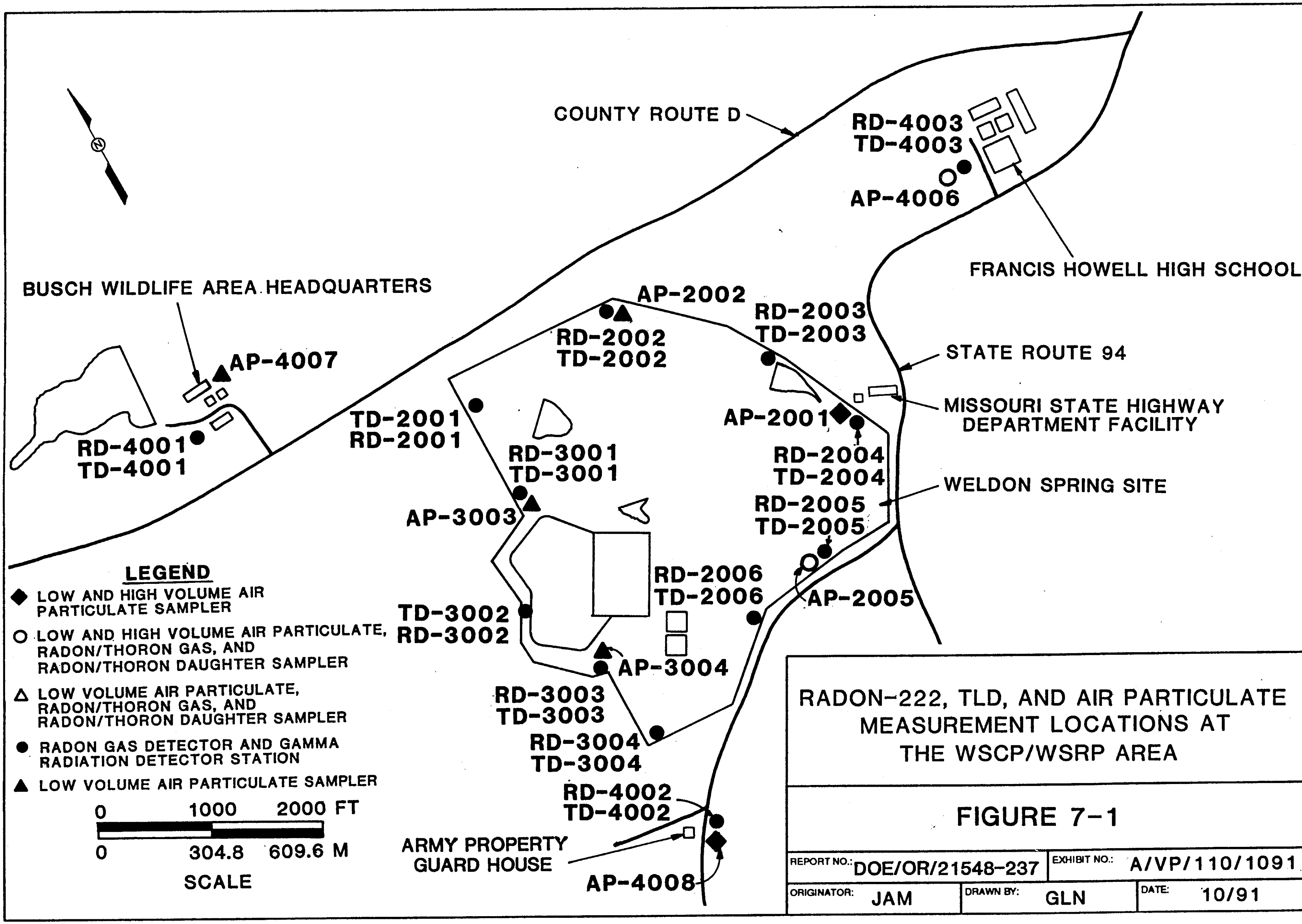
The locations chosen as external monitoring stations were based on the characteristics of the WSS. The potential for external gamma exposures to a member of the public as a result of fugitive dust emissions from the WSS is an unrealistic exposure pathway. Any airborne emission from the WSS will be intermittent, have low concentrations of radionuclides, and would have a low probability of drifting toward a location where a member of the public would frequent. Thus, this pathway would not result in a measurable external exposure to a member of the general public. In addition, there are no high energy accelerators, industrial x-ray, or large isotopic radiation sources present at the WSS. The only potential for external exposure to a member of the general public results from contaminated soils located at the WSCP/WSRP, WSQ, and vicinity properties.

Exposure from gamma radiation at the WSS will be monitored at 30 monitoring stations using environmental TLDs. Ten monitoring stations are located around the perimeter fence of the WSCP/WSRP (Figure 7-1). Five will be located around the perimeter of the temporary storage area (TSA) (Figure 7-2) located within the WSCP/WSRP. The TSA is one of the waste control facilities to be utilized in 1992 for the storage of bulk radioactive and chemical wastes from the WSQ. Eight monitoring stations will be located along the WSQ perimeter fence (Figure 7-3) spaced at intervals of 80 ft to 350 ft.

The 10 monitoring stations at the WSCP/WSRP are spaced at intervals ranging from 700 ft to 2,000 ft around the site perimeter. The five TSA monitoring stations will be located around the perimeter at intervals of 420 ft to 780 ft. The six monitoring stations at the WSQ will be spaced at intervals of 300 ft to 840 ft. The monitors at the perimeters of the WSCP/WSRP, TSA, and WSQ will be used to measure gamma exposure rates at the boundaries of those areas.

Spacing of the monitoring stations around the perimeters of the WSCP/WSRP, TSA, and WSQ is based on the relative potential for external exposures. The perimeter of the WSQ, which has the shortest distances between monitoring stations, is the most accessible to a member of the general public. In addition, the contaminated materials within the WSQ at some points are less than 150 ft from the perimeter. The intervals between monitoring stations at the TSA are similar to those at the WSQ. Material presently at the WSQ will begin to be moved to the TSA during 1992. In some places the TSA perimeter is less than 100 ft from the WSCP/WSRP perimeter. The intervals between monitoring stations at the WSCP/WSRP perimeter are larger because the potential for external exposure to a member of the general public at the WSCP/WSRP perimeter is less significant.

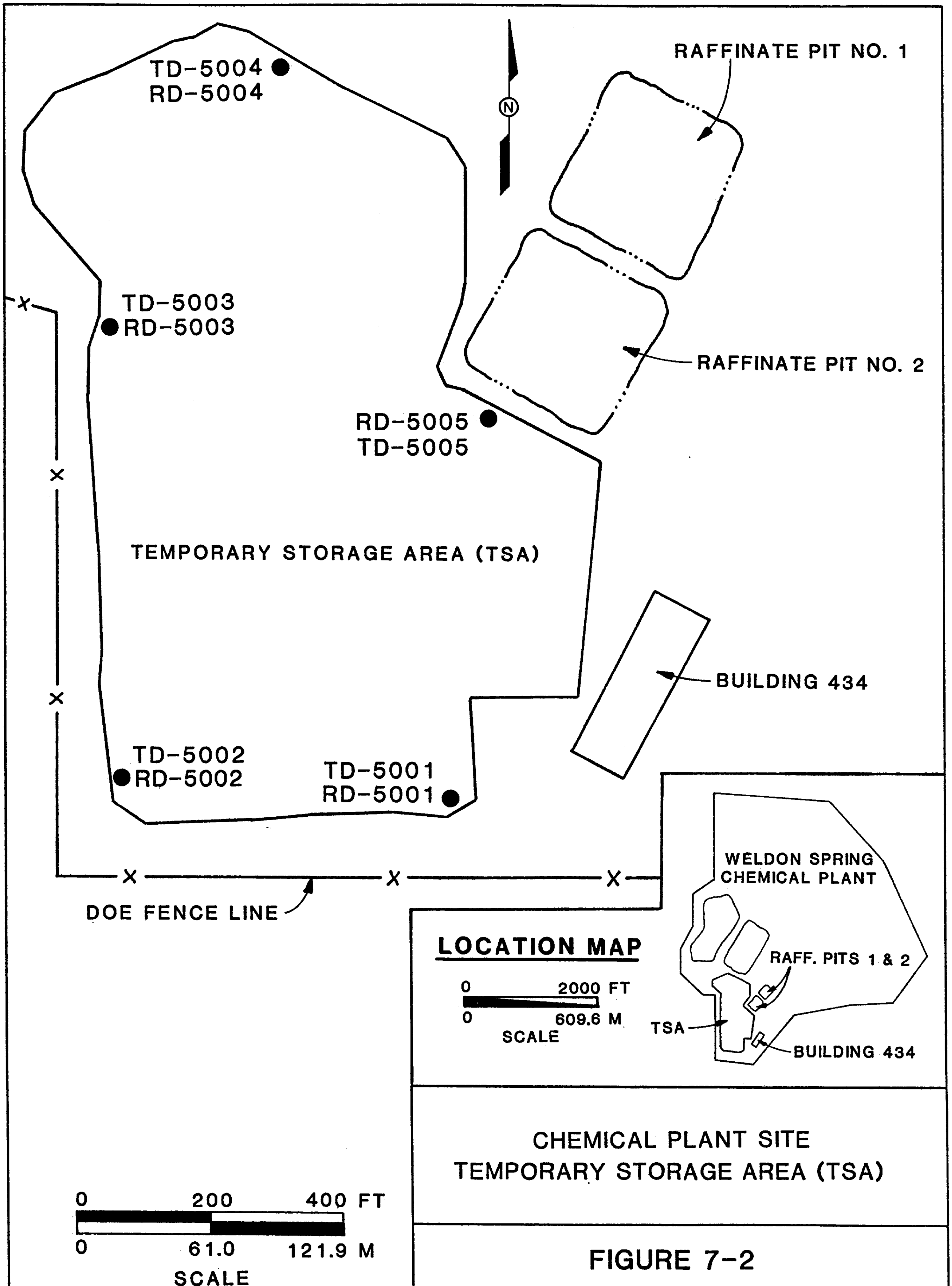
Five off-site monitoring stations (Figure 7-1), as well as two of the perimeter monitoring stations, will be used to assess gamma radiation exposure rates at locations near the WSCP/WSRP where members of the general public abide or reside. The monitoring stations at the Francis Howell High School and the Busch Wildlife headquarters were chosen because they have the largest populations near the WSCP/WSRP. The State of Missouri Highway Department, TD-2004; the Army Reserve guard house, TD-4002; and the WSSRAP administration building, TD-2005; are the closest locations to the WSCP/WSRP where a member of the general public abides or resides.



RADON-222, TLD, AND AIR PARTICULATE MEASUREMENT LOCATIONS AT THE WSCP/WSRP AREA

FIGURE 7-1

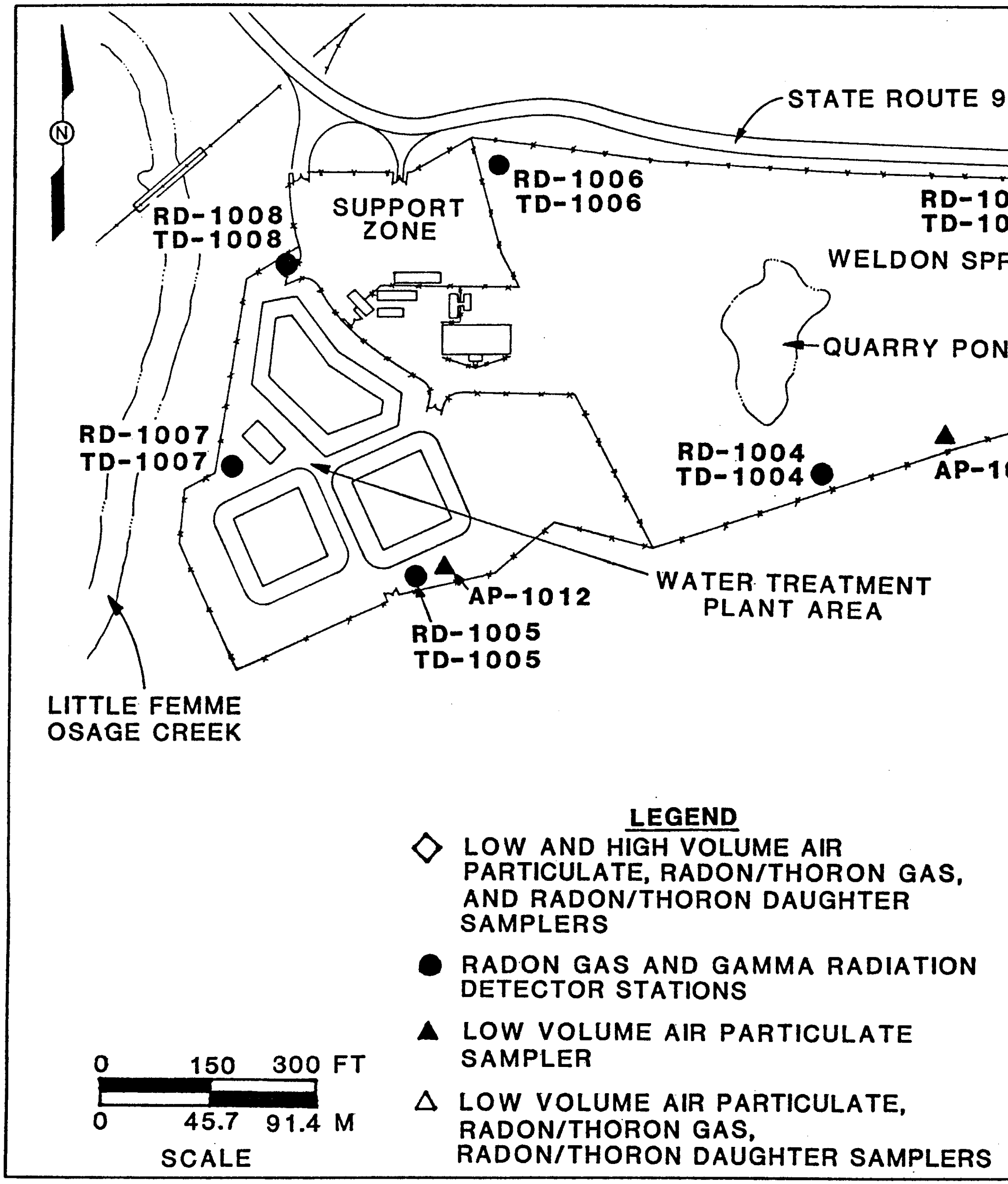
REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/VP/110/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91	

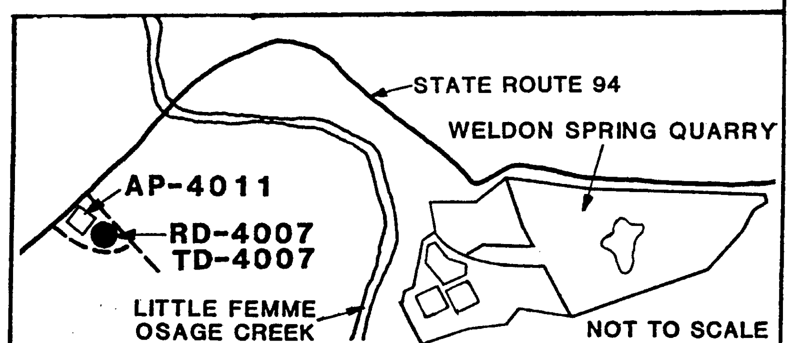


CHEMICAL PLANT SITE
TEMPORARY STORAGE AREA (TSA)

FIGURE 7-2

REPORT NO.:	DOE/OR/21548-237	EXHIBIT NO.:	A/DC/004/1091		
ORIGINATOR:	JAM	DRAWN BY:	GLN	DATE:	10/91

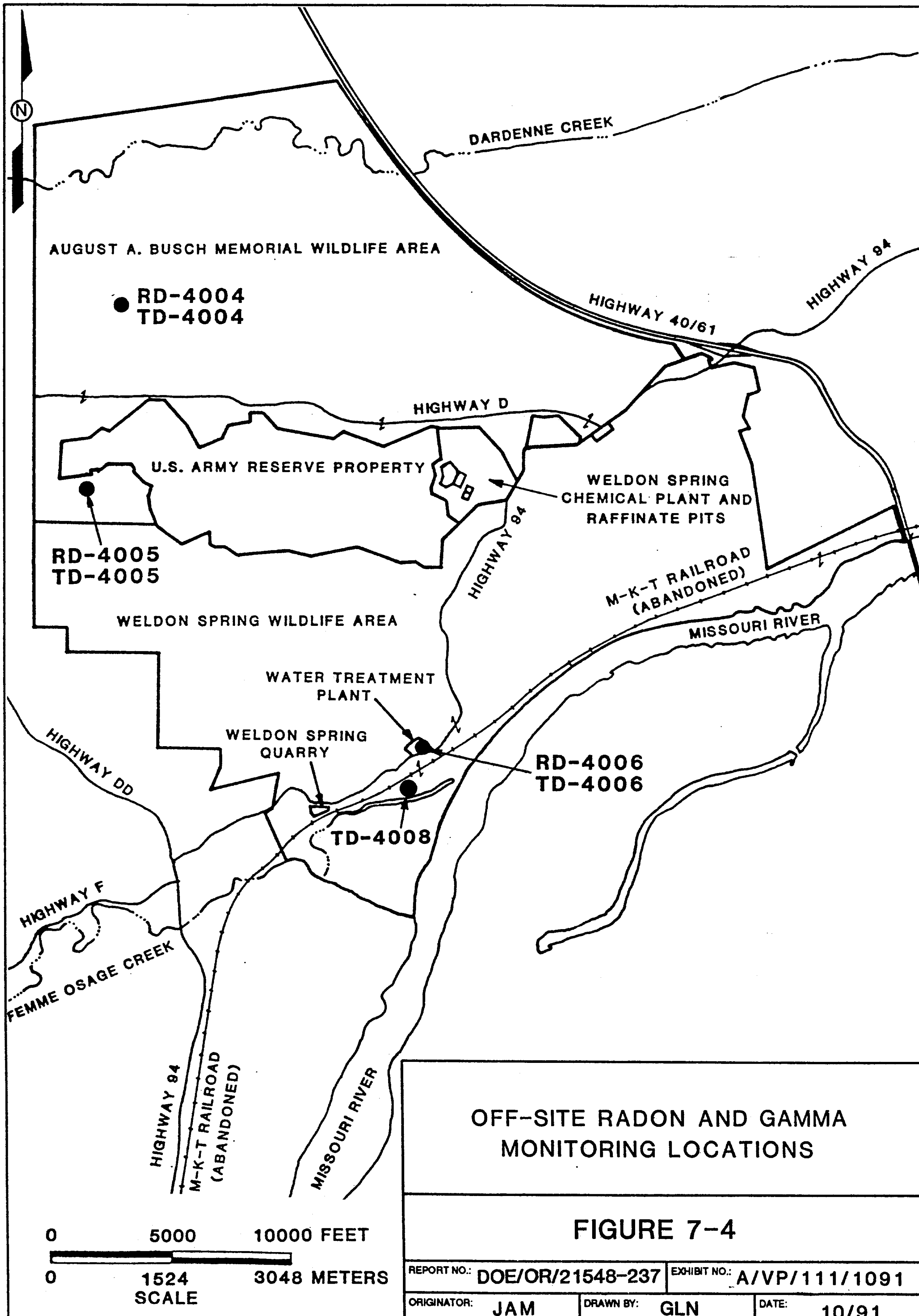




RADON-222, TLD, AND AIR PARTICULATE MEASUREMENT LOCATIONS AT THE WSQ AREA

FIGURE 7-3

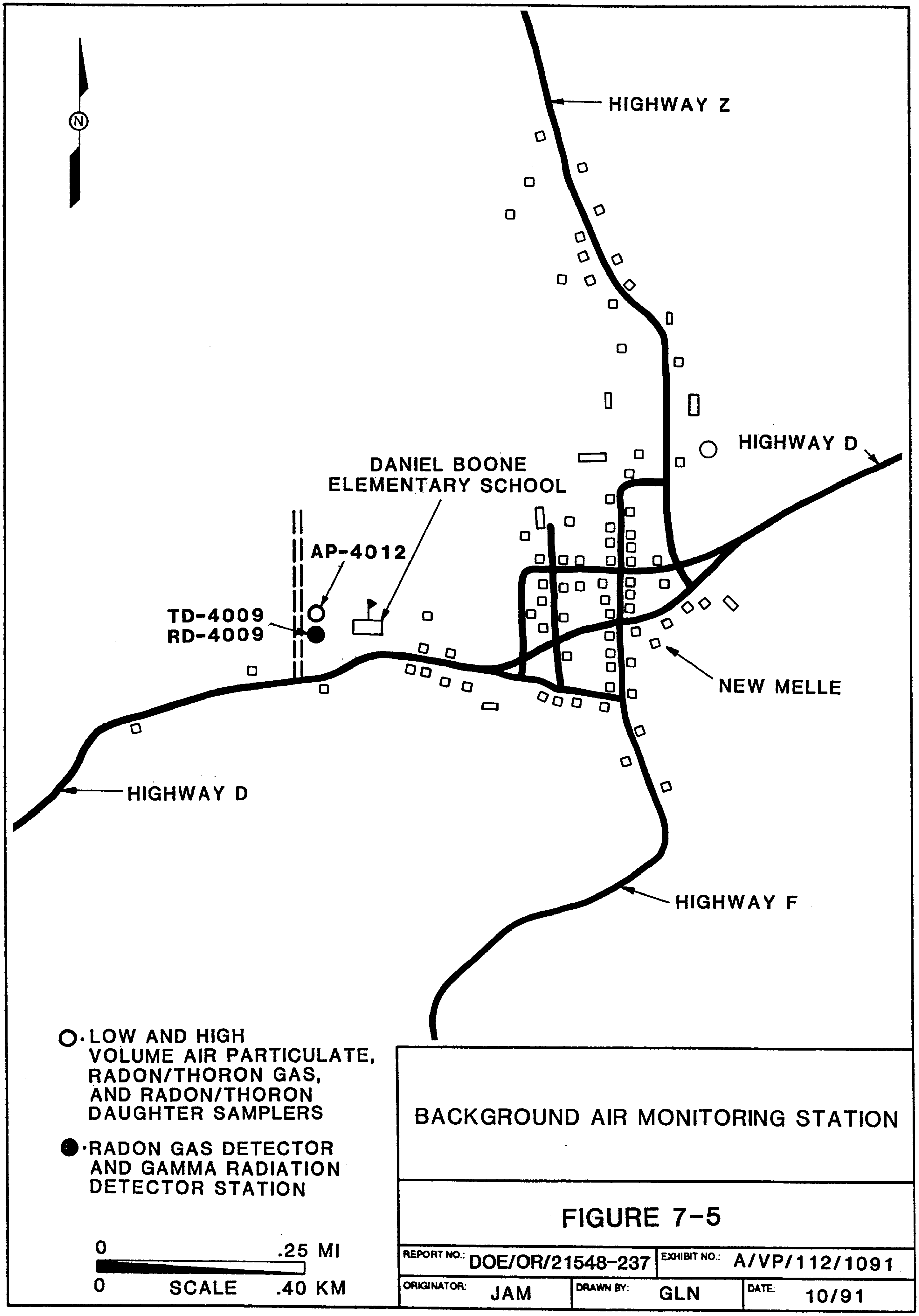
REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/QY/076/1091
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91



OFF-SITE RADON AND GAMMA MONITORING LOCATIONS

FIGURE 7-4

REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/VP/111/1091
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91



BACKGROUND AIR MONITORING STATION

FIGURE 7-5

REPORT NO.: DOE/OR/21548-237	EXHIBIT NO.: A/VP/112/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91

The monitoring station near the residence, TD-4007 (Figure 7-3), was chosen because the individuals who reside there have an assumed continuous exposure time, the longest of any of the WSS nearby receptors. The location at the Femme Osage Slough vicinity property, TD-4008, was chosen because it has the greatest potential of the WSS vicinity properties to cause an external dose to a member of the general public. The Femme Osage Slough vicinity property is located near the Katy Trail, which has the largest population group that visits the WSS vicinity, and is used by individuals who fish from the Femme Osage Slough.

Five monitoring stations are used to measure background gamma radiation exposure rates (Figures 7-1, 7-4 and 7-5). The monitoring locations are TD-4001, TD-4004, TD-4005, TD-4006, and TD-4009. In 1989, background gamma radiation exposure rates were measured in each of the three distinct geological regions in the vicinity of the WSS. The three distinct regions are the dissected glacial till deposits, the alluvial deposition of the Missouri River, and the Salem Plateau. Statistical analysis of the data from the background measurements indicated that at the 95% confidence level there was no reason to suspect a difference in the gamma exposure rates between the three geological regions. Since there was no reason to suspect a difference between the gamma exposure rates in the three geological regions, an average of the results of the five background locations will give a better approximation of the background gamma radiation exposure rate.

Four of the background monitoring stations are within 4 mi of the WSCP/WSRP or WSQ. The fifth background station, TD-4009, is approximately 8 mi from the WSCP/WSRP and 7 mi from the WSQ. The *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991) suggests that background stations should be located at a minimum of 6 mi to 9 mi from a site. Although three of the background stations are not located at the distances suggested in the *Regulatory Guide*, they are at appropriate distances with respect to the WSS. As mentioned, the WSS will not render external radiation exposures as a result of any airborne emissions. There are no high energy accelerators, industrial X-ray, or large isotopic radiation sources at the WSS, thus the distances that the four background stations are from the WSCP/WSRP or vicinity properties are more than sufficient to attenuate the gamma radiation from on-site contaminated soils.

Measurements with a pressurized ion chamber (PIC) as suggested in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991) will not be made at monitoring stations used in previous years. Because the TLDs integrate gamma exposure for 13 wk, the TLDs actually provide a better assessment to determine if any natural occurring anomalies are present at the location than would a short term PIC measurement. Results of previous TLD measurements are consistent with yearly background gamma exposures made by the Project Management Contractor (PMC) and other DOE contractors around the WSS. Results have ranged from 60 mR/year to 104 mR/year (BNI 1984; BNI 1985a; BNI 1985b, and MKF and JEG 1989a), with the exception of some of the monitoring stations at the WSQ. The monitoring stations at the WSQ, located in the controlled area, are positioned near contaminated soils and material. The above background results are due to the proximity of the monitoring stations to the contaminated soils. Because previous TLD measurements are consistent with background exposure rates performed by the PMC and others and are within the expected range for this altitude, it is concluded that there are no naturally occurring anomalies present. Thus, pressurized ionization chamber (PIC) measurements are not necessary.

New monitoring locations in 1992 include: background monitoring station TD-4009, monitoring station TD-4008 at the Femme Osage Slough, monitoring station TD-4007 near the residence west of the WSQ, WSQ perimeter stations TD-1005, TD-1007, and TD-1008, and WSCP/WSRP perimeter stations TD-2004 and TD-2005. The WSQ perimeter station TD-1005 and the WSCP/WSRP perimeter station TD-2004 and TD-2005 are previously existing stations which have been moved to new locations in order to obtain more useful monitoring data. Prior to installation of the new monitoring stations, a survey of the locations will be conducted as suggested in the *Regulatory Guide* to determine the absence of possible naturally occurring anomalies that could affect later measurements. The survey will be conducted with a PIC.

The five monitoring stations at the TSA, TD-5001, TD-5002, TD-5003, TD-5004, and TD-5005 will also be new stations in 1992. Because these stations are located in the controlled area where contaminated soils will be stored, PIC measurements are not necessary prior to installation of the stations. Measurements would be expected to be greater than background due to the contaminated soils in the area. However, baseline measurements will be taken with TLDs prior to arrival of bulk waste material from the WSQ to the TSA. The TLDs will be placed at the TSA for 13 weeks (calendar quarter) and from that data any increase in the external gamma radiation exposure rate as a result of TSA activities can be assessed.

The quality control measures that will be implemented for environmental TLDs include duplicates, chain-of-custody forms, field sheets, and review of vendor data. At least two duplicate TLDs will be deployed, one at the WSQ and one at the WSCP/WSRP. When the TLDs are exchanged and retrieved, field sheets will be used to document placement and any unusual occurrences. Chain-of-custody forms will also be filled out as specified in the appropriate WSSRAP standard operating procedures (SOP). The data that is received from the vendor will be reviewed and any anomalies identified and investigated. In addition, performance testing and deployment and storage of TLDs will be done according to ANSI-N545-1975 and Nuclear Regulatory Commission (NRC) Regulatory Guide 4.13.

8 EFFLUENT MONITORING

The Weldon Spring Site Remedial Action Project (WSSRAP)has established two distinct monitoring programs which it characterizes as "effluent monitoring." These include airborne and waterborne effluents which might exceed the site perimeters. These programs are described in detail in the following sections.

8.1 National Pollution Discharge Elimination System (NPDES) Program

As a Federal facility, the WSSRAP is subject to, and complies with, Executive Order 12088, which requires all Federal facilities to comply with applicable pollution control standards. Further, U.S. Department of Energy (DOE) Order 5400.1 states that the DOE is to "conduct operations in compliance with the letter and spirit of applicable environmental ... regulations and standards." In this light, and since the WSSRAP contains point sources for waterborne pollutants, the project operates in compliance with Clean Water Act requirements.

8.1.1 Goal

To minimize the discharge of waterborne contaminants from the site, WSSRAP policy dictates that all surface water be closely monitored and controlled with treatment as necessary. Table 8-1 presents the known sources of water on the site. Erosion is to be minimized and sediment removed to a level commensurate with "best available technology." Contaminated water on the site is to be treated where appropriate, to ensure that water discharges meet Federal and State requirements.

The objective of the effluent monitoring program is to establish a base of information regarding water treatment requirements, and to verify compliance with State and Federal regulations. The remedial action goal is to clean up the site with no increase in contaminant discharge or degradation of the off-site streams. The elements of the program consist of source identification, periodic sampling and analysis to determine treatment requirements, transport, and treatment as required.

The program consists of studies and reports to identify, analyze, and evaluate appropriate measures to accomplish effective control of runoff, erosion, sediment, and contamination

TABLE 8-1 Existing or Potential Water Sources

SOURCE	CATEGORY*	QUANTITY
Raffinate Pits No. 1	RAD	1.3×10^6 gal
2	RAD	1.3×10^6 gal
3	RAD	7.7×10^6 gal
4	RAD	32.9×10^6 gal
Frog Pond	STR	500,000 gal
Ash Pond	STR	1,800,000 gal
Decontamination Pad	RAD	8.3 gpm
TSA (10 ac)	RAD	9,800,000 gpy
MSA (9 ac)	STR	8,800,000 gpy
Office Toilets	SAN	4,000 gpd
Laundry	SAN	2,500 gpd
Access Control Toilets	SAN	---
Laboratory	TBD	---
Sumps and Tanks	TBD	---
Stormwater Discharges (200 ac)	STR	195,000,000 gpy
Worker Toilets	SAN	---
Worker Showers	SAN	1.7 gpm
Decontamination Facilities	RAD	---
Ash Pond Diversion Pond	STR	---
Retention Basins	STR	---
Sewerage System	TBD	---
QUARRY		
Quarry Sump	RAD	3,000,000 gal
Quarry Stormwater (9 ac)	RAD	8,800,000 gpy
Quarry Washdown	RAD	2.5 gpm
Decontamination Pad	RAD	2.0 gpm
Worker Toilets	SAN	---
Worker Showers	SAN	0.6 gpm

SOURCE	CATEGORY*	QUANTITY
VICINITY PROPERTIES		
Femme Osage Slough	STR	---
Busch Lake No. 34	STR	---
Busch Lake No. 35	STR	---
Busch Lake No. 36	STR	---

* Category is based on the primary treatment method required and existing natural uranium concentration.

SAN Biological Treatment; Uranium - background to 30 pCi/l
STR Sediment Treatment; Uranium - less than DCG, 600 pCi/l
RAD Complex Treatment; Uranium - greater than DCG, 600 pCi/l
TBD To Be Determined

sources. Also, procedures are required to ensure that appropriate measures are designed and built into projects, and to ensure appropriate maintenance measures are practiced.

8.1.2 Effluent Evaluation

Effluent monitoring at the Weldon Spring site (WSS) includes five surface water outfalls, one treated sanitary sewer discharge from the administration building, and one treated water discharge from the site treatment facility designed to treat the various contaminated waters that exist on the property. The wastewater treatment facility at the Weldon Spring Quarry (WSQ) will operate one permitted outfall. The treatment plant will treat contaminated water from several sources: (1) WSQ pond, (2) stormwater, and (3) waste water resulting from the equipment decontamination facility. Also, at the quarry water treatment plant, there will be a discharge or discharges of uncontaminated water used to test the treatment plant, ponds, and associated equipment. A similar discharge is proposed for the site water treatment plant.

Preoperational monitoring of receiving waters associated with both water treatment plants will be continued into 1992 to develop baseline values prior to operation. All of these discharges are monitored in accordance with National Pollutant Discharge Elimination System (NPDES) permits issued to the WSS by the Missouri Department of Natural Resources (MDNR).

Existing or potential site water sources are listed in Table 8-1. An estimate of the quantity of the sources are described in rates or total volume depending on the source. The current treatment category is also provided for the source. Certain of the waters, however, are not clearly defined and the treatment category for these waters will also require monitoring on a case-by-case basis for final determination.

8.1.2.1 Permitted Outfalls. Three permits have been issued by the Missouri MDNR for discharges from the WSSRAP. Permit MO-0107701 for the chemical plant contains seven outfalls and MO-0108987 for the quarry contains one outfall. *Quarterly Discharge Monitoring Reports* (DMR's) are required as compliance deliverables for these outfalls. Permit MO-G340001 for the quarry water treatment plant contains one outfall that requires a discharge monitoring report (DMR) as a compliance deliverable within 30 days of each discharge event. A similar outfall is proposed for the site water treatment plant. The *Annual Site Environmental Report* (ASER) (MKF and JEG 1991) and the *Quarterly Environmental Data Summaries* (QEDSs) also summarize the data from these outfalls. Discharge data is also reported to EG&G Idaho Nuclear Engineering Laboratories (INEL) and to DOE's Oak Ridge - Environmental Protection Division (OR-EPD) as detailed in the *Effluent Information System* (EIS) and *Onsite Discharge Information System (ODIS) Users Manual* (EG&G 1977).

NPDES permit MO-0107701 was issued to the DOE on July 29, 1988, for the discharge of surface water runoff through five outfalls from the Weldon Spring Chemical Plant (WSCP). A sixth outfall was added on November 4, 1988, for discharge from the sewage treatment plant at the administration building. A seventh outfall was added on October 1, 1990, for the discharge of treated effluent from the WSCP water treatment plant which will be used to treat contaminated water during remedial activities at the WSCP. Operation of the treatment facility associated with outfall NP-0007 will include storage of treated effluent (for additional treatment if necessary) until testing confirms all effluent standards have been met. Figure 8-1 shows the location of the permitted outfalls from the site.

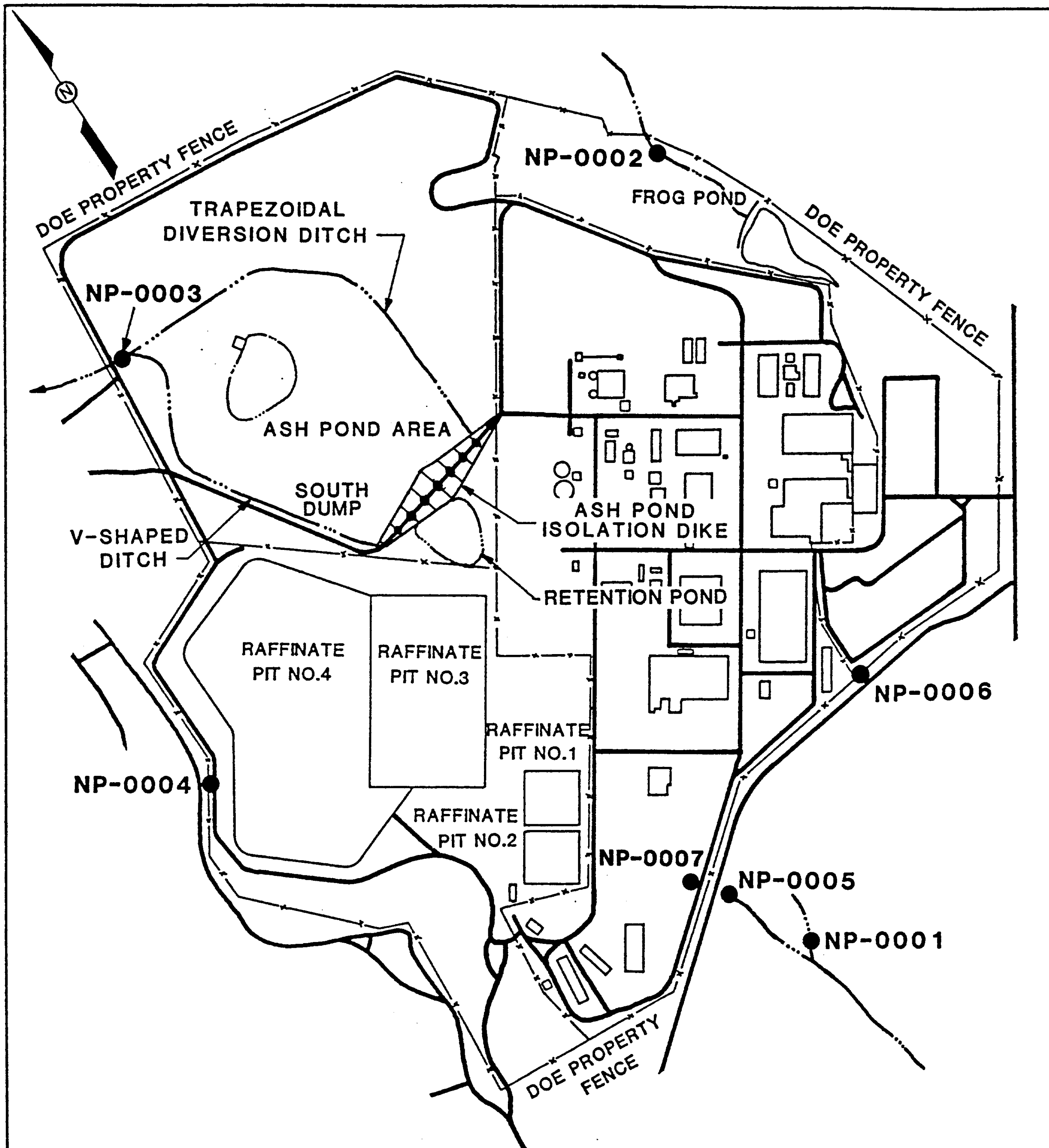
NPDES permit MO-0108987 was issued to the DOE on May 5, 1989, for the discharge of treated effluent from the WSQ water treatment plant which will be used to treat contaminated water during remedial activities at the WSQ. Operation of this treatment plant will include storage of treated effluent (for additional treatment if necessary) until testing confirms all effluent standards have been met. Figure 8-2 shows the permitted outfall for the quarry.

NPDES permit MO-G340001 was issued to the DOE on December 19, 1991, for the discharge of contaminated water used to conduct tests on the quarry water treatment plant, basins, and associated equipment. The water will be pumped from the basins to Little Femme Osage Creek.

8.1.2.2 Permitted Parameters. Monitoring parameters for the stormwater outfalls NP-0001 through NP-0005 include: flow, settleable solids, total suspended solids (TSS), nitrate-N, uranium, lithium, gross alpha, and pH. The parameters for the discharge for the administration building sanitary treatment system (NP-0006) include: flow, total suspended solids (TSS), pH, biological oxygen demand (BOD), and fecal coliform (Table 8-2). Monitoring parameters for outfall NP–0007 at the chemical plant and NP-1001 at the WSQ water treatment plant are similar and are shown on Table 8-3. These parameters are to be monitored before a batch of treated effluent is discharged to the Missouri River. The parameters for the chemical plant will be monitored at two locations; in the effluent basins prior to discharge to the Southeast Drainageway (NP-0007), and in the drainageway prior to discharge to the river to assess reintroduction of contaminants from the drainageway.

In addition to the batch parameters, other parameters are periodically monitored. Monitoring for 110 priority pollutants (Table 8-4) is required for these discharges once per year. These priority pollutants are organic compounds that are included in the following major categories: volatile organic compounds, semi-volatile organic compounds, pesticides, and polychlorinated biphenyls (PCBs). During the public comment period, xylene and trinitrotoluene (TNT) were added to the list of 110 priority pollutants. Priority pollutants for the chemical plant will be monitored at the same two locations as the other parameters.

Additional monitoring associated with these discharges includes in-stream monitoring to be conducted during discharge of each batch of treated effluent into the Missouri River. Four in-stream monitoring locations in the Missouri River are to be monitored for the following radiological parameters (expressed as activity): gross alpha, gross beta, uranium, Ra-226, Ra-228, Th-230, and Th-232. These radiochemical species constitute the primary radiological concern to potential downstream receptors. If measured levels appear to show an influence by site discharge, gross gamma emitters will be analyzed to evaluate incremental contribution toward proposed gamma and photon maximum contaminant level (MCL).



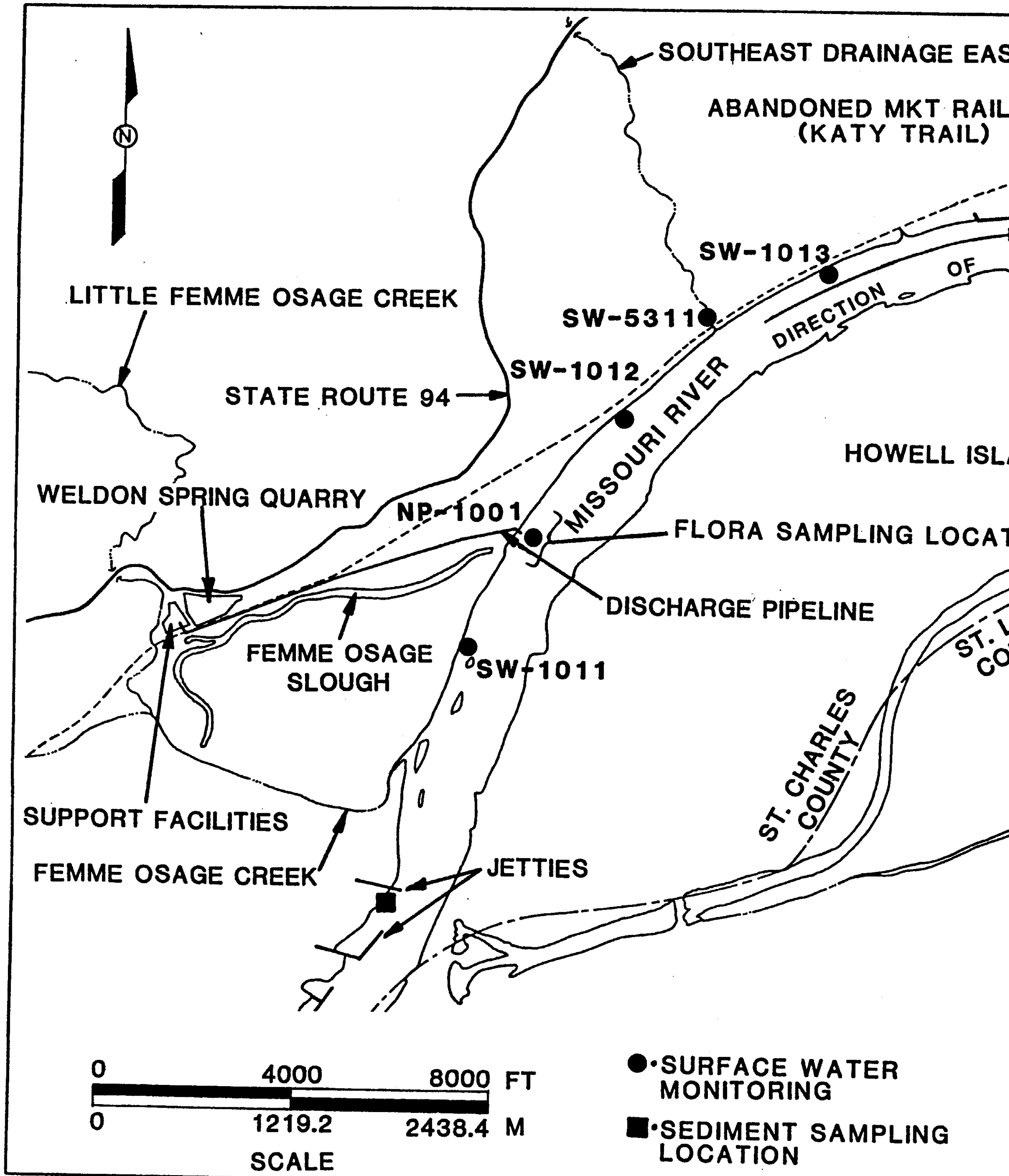
● -SAMPLE LOCATION

SCALE 0 500 1000 FT
0 152.4 304.8 M

NPDES SURFACE WATER SAMPLING LOCATIONS AT THE WSCP/RP

FIGURE 8-1

REPORT NO DOE/OR/21548-237		EXHIBIT NO.: A/CP/157/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91	



MISSOURI RIVER SAMPLING LOCATIONS

FIGURE 8-2

REPORT NO.: DOE/OR/21548-237		EXHIBIT NO.: A/VP/113/1091	
ORIGINATOR: JAM	DRAWN BY: GLN	DATE: 10/91	

TABLE 8-2 NPDES Permit Monitoring Requirements - Sanitary and Stormwater Sources

PARAMETERS	UNITS	PERMITTED LIMIT	ANALYTICAL METHOD
SITE NP-001 thru NP-0005			
NP-0002, NP-0003, AND NP-0005 Monthly Monitoring of One Storm			
Flow	GPD	Monitor	V-notch weir
Settleable Solids	ml/l	(Monitor until ROD) 1	EPA 160.5
Total Suspended Solids (TSS)	mg/l	Monitor	EPA 160.2
Nitrate	mg/l	Monitor	EPA 352.1
Lithium	mg/l	Monitor	EPA 200.7
Uranium	mg/l	Monitor	EPA 900
Gross Alpha	pCi/l	Monitor	EPA 908.1
pH	SU	6-9	Beckman Ø11 Meter
NP-0001 and NP-0004 Quarterly Monitoring			
Flow	GPD	Monitor	Visual
Settleable Solids	ml/l	(Monitor with ROD) 1	EPA 160.5
Total Suspended Solids (TSS)	mg/l	Monitor	EPA 160.2
Nitrate	mg/l	Monitor	EPA 352.1
Lithium	mg/l	Monitor	EPA 200.7
Uranium	mg/l	Monitor	EPA 900
Gross Alpha	pCi/l	Monitor	EPA 908.1
pH	SU	6-9	Beckman Ø11 Meter
NP-0006 Monthly and Quarterly Monitoring			
Flow	GPD	Monitor	Pump Meters
Total Suspended Solids (TSS)	mg/l	15/20*	EPA 160.2
pH	SU	6-9	Meter
Biological Oxygen Demand (BOD)	mg/l	10/15*	EPA 405.1
Fecal Coliform	Colonies/100 ml	400/1,000*	STM 909A

* Monthly average/weekly average
** Monthly average/daily maximum

TABLE 8-3 NPDES Permit Monitoring Requirements - Complex Treatment

PARAMETER	PERMIT LIMIT	FREQUENCY	SAMPLE TYPE
Site NP-0007 and Quarry NP-1001			
Flow	Monitor, MGD	once/batch	24-hr total
Biochemical Oxygen Demand	Monitor, mg/l	once/batch	grab
Chemical Oxygen Demand	90/60 mg/l*	once/batch	grab
Total Suspended Solids	50/30 mg/l*	once/batch	grab
pH	6-9 standard units	once/batch	grab
Arsenic, Total	0.10 mg/l	once/batch	grab
Barium, Total	1.50 mg/l	once/batch	grab
Cadmium, Total	0.02 mg/l	once/batch	grab
Chromium, Total	0.10 mg/l	once/batch	grab
Copper, Total	1.0 mg/l	once/batch	grab
Iron, Total	0.6 mg/l	once/batch	grab
Lead, Total	0.1 mg/l	once/batch	grab
Manganese, Total	0.1 mg/l	once/batch	grab
Mercury, Total	0.004 mg/l	once/batch	grab
Selenium, Total	0.02 mg/l	once/batch	grab
Silver, Total	0.10 mg/l	once/batch	grab
Zinc, Total	5.0 mg/l	once/batch	grab
Cyanide, Total	0.0075 mg/l	once/batch	grab
Asbestos	Monitor fibers/l	once/batch	grab
2,4-DNT	0.22 μg/l	once/batch	grab
Fluoride, Total	4.0 mg/l	once/batch	grab
Nitrate as N: Site	20 mg/l	once/batch	grab
Quarry	Monitor mg/l	once/batch	grab
Sulfate as SO_4	500 mg/l	once/batch	grab
Chloride	Monitor mg/l	once/batch	grab
Gross Alpha	Monitor pCi/l	once/batch	grab
Gross Beta	Monitor pCi/l	once/batch	grab
Uranium, Total	Monitor pCi/l	once/batch	grab

TABLE 8-3 NPDES Permit Monitoring Requirements - Complex Treatment (Continued) 012392

PARAMETER	PERMIT LIMIT	FREQUENCY	SAMPLE TYPE
Ra-226, Total	Monitor pCi/l	once/batch	grab
Ra-228, Total	Monitor pCi/l	once/batch	grab
Th-230	Monitor pCi/l	once/batch	grab
Th-232	Monitor pCi/l	once/batch	grab

* Daily maximum/monthly average.

TABLE 8-4 NPDES Permit Monitoring Requirements Priority Pollutant List Quarry NP-1001 and Site NP-0007

Acenaphthene	4-chlorophenyl phenyl ether
Acrolein	4-bromophenyl phenyl ether
Acrylonitrile	Bis (2-chloroisopropyl) ether
Benzene	Bis (2-chloroithexy) methane
Benzidine	Methylene Chloride (dichloromethane)
Carbon Tetrachloride (tetrachloromethane)	Methyl Chloride (chloromethane)
Chlorobenzene	Methyl bromide (bromomethane)
1,2,4-trichlorobenzene	Bromoform (tribromomethane)
Hexachlorobenzene	Dichlorobromomethane
1,2-dichloroethane	Chlorodibromomethane
1,1,1-trichloroethane	Hexachlorobutadiene
Hexachloroethane	Hexachlorocyclopentadiene
1,1-dichloroethane	Isophorone
1,1,2-trichloroethane	Naphthalene
1,1,2,2-tetrachloroethane	Nitrobenzene
Chloroethane	2-nitrophenol
Bis (2-chloroethyl) ether	4-nitrophenol
2-chloroethyl vinyl ether	2,4-dinitrophenol
N-nitrosodi-n-propylamine	4,6-dinitro-o-cresol
Pentachlorophenol	N-nitrosodimethylamine
Phenol	N-nitrosodiphenylamine
Bis (2-ethylhexyl) phthalate	Phenanthrene
Butyl benzyl phthalate	1,2,5,6-dibenzanthracene (dibenzo(a,h)anthracene)
Di-n-butyl phthalate	Indeno (1,2,3-cd) pyrene (2,3-o-phenylene pyrene)
Di-n-octyl phthalate	Pyrene
Diethyl phthalate	Tetrachloroethylene
Dimethyl phthalate	Toluene
1,2-benzanthracene (benzo(a)anthracene)	Trichloroethylene
Benzo(a)pyrene (3,4-benzopyrene)	Vinyl Chloride (chloroethylene)

TABLE 8-4 NPDES Permit Monitoring Requirements Priority Pollutant List Quarry NP-1001 and Site NP-0007 (Continued)

3,4-benzofluoranthene (benzo(b)fluoranthene)	Aldrin
11,12-benzofluoranthene (benzo(k)fluoranthene)	Dieldrin
Chrysene	Chlordane (technical mixture and metabolites)
Anthracene	4,4-DDT
1,12-benzoperylene (benzo(ghi)perylene)	4,4-DDE (p,p-DDX)
Fluorene	4,4-DDD (p,p-TDE)
2-chloronaphthalene	Alpha-endosulfan
2,4,6-trichlorophenol	Beta-endosulfan
Parachlorometa cresol	Endosulfan sulfate
Chloroform (trichloromethane)	Endrin
2-chlorophenol	Endrin aldehyde
1,2-dichlorobenzene	Heptachlor
1,3-dichlorobenzene	Heptachlor epoxide (BHC hexachlorocyclohexane)
1,4-dichorobenzene	Alpha-BHC
3,3-dichlorobenzidine	Beta-BHC
1,1-dichloroethylene	Gamma-BHC
1,2-trans-dichloroethylene	Delta-BHC (PCB polychlorinated biphenyls)
2,4-dichlorophenol	PCB-1242 (Arochlor 1242)
1,2-dichloropropane (1,3-dichloropropane)	PCB-1254 (Arochlor 1254)
2,4-dimethylphenol	PCB-1221 (Arochlor 1221)
2,4-dinitrotoluene	PCB 1232 (Arochlor 1232)
2,6-dinitrotoluene	PCB-1248 (Arochlor 1248)
1,2-diphenylhydrazine	PCB-1260 (Arochlor 1260)
Ethylbenzene	PCB-1016 (Arochlor 1016)
Fluoranthene	Toxaphene
Xylene*	2,4,6-trinitrotoluene*

* QY NP-1001 only

Table 8-5 NPDES Permit MO-G340001, Monitoring Requirement - Quarry Water Treatment Plant Equipment Testing

Parameter	Permit Limit	Frequency	Sample Type
Flow	Monitor-Total Gal.	Once/event	24-hr total
Oil and grease	15 mg/l	once/event	grab
Total suspended solids	50 mg/l	once/event	grab

Additional periodic monitoring is required for other parameters such as whole effluent toxicity (WET) screens, supplemental monitoring of additional radionuclides, analysis of river sediment for uranium, and uranium analysis of terrestrial and aquatic flora. In order to encourage good erosion control practices, both NPDES permits place limitations on total suspended solids and pH for runoff from material storage or construction areas.

The parameters required for the water treatment plant equipment and basin testing, permit MO-G340001, include flow, oil, and grease and total suspended soilds (Table 8-5).

8.1.3 Preoperational Needs

DOE Order 5400.1 requires preoperational monitoring of processes which have the potential for environmental impact. Preoperational monitoring will be performed in or near the Missouri River since this is the receiving stream for discharge from both of the water treatment plants.

8.1.3.1 Sampling and Analysis. This monitoring includes surface water, sediment, and vegetation (aquatic and terrestrial) and will include all of the parameters that are regulated by the permits. Preoperational monitoring for uranium in surface water began in 1989 at locations SW-1011, SW-1012, and SW-1013 shown on Figure 8-2. In 1991, the parameters listed in Table 8-2 were added at these locations in addition to SW-1015 and SW-5311 also shown on Figure 8-2. These sample locations are positioned such that analytical data for these four locations may be used as preoperational data for discharges associated with both the WSQ and WSCP treatment plants. Monitoring will continue into 1992 for the above, as well as for total uranium on sediments and flora (terrestrial and aquatic).

8.1.3.2 Additional River Data. In addition to the sampling and analysis of the Missouri River for preoperational parameters, existing data reported by others will be obtained to expand the available data base. A major source of information is the river monitoring by Union Electric relative to the Callaway Power Generation facility. Raw water data from the Howard Bend Water Treatment Plant and its neighbor, the Hog Hollow Water Treatment Plant will also be retrieved. These represent the nearest downstream public water supply intakes from the Missouri River.

8.1.4 Additional Monitoring

8.1.4.1 Outfall Upsystem Sources. The source of runoff through the stormwater outfalls is from a variety of storm control systems including storm sewers, drainage channels, and retention basins. Monitoring these upsystem facilities is not part of the permit requirements, but they are sources for contamination of the outfalls. Monitoring is often needed to fully understand the waste characteristics at the permitted outfall. With this in mind, additional samples will be taken in these upstream facilities and may be taken in other areas on a case-by-case basis. Since explanations of exceedance are required by the MDNR when the sampling results vary significantly from the norm, upsystem data are often needed for these explanations.

8.1.4.2 New Stormwater Regulations. On November 16, 1990, the U.S. Environmental Protection Agency (EPA) issued the long awaited rule defining the entities which must apply for NPDES permits to discharge stormwater. These regulations implement Section 405 of the Water Quality Act of 1987, and require selected industries and municipalities to obtain NPDES stormwater permits from all storm drains exiting to public waterways. Initial attempts to regulate stormwater began in 1973. The deadline for individual industrial permits has been established as October 1, 1992.

The WSSRAP is subject to these rules because: (1) it currently processes five permitted outfalls which are considered stormwater; (2) it is classed in our permits as SIC 1629-heavy construction, dredging and surface cleanup; (3) it was historically involved in the mineral industry, coal handling, and hazardous materials; and (4) it is a future construction site of landfill, treatment works, decontamination, and recycle facilities.

Although additional monitoring requirements may not be needed in 1992, the rule will require that monitoring data be developed prior to reissuing of the permits. This data will be associated with two types of permit requirements.

- One application deals with the runoff from sites potentially contaminated from operating facilities and stored materials. This requirement applies to the WSSRAP, although facilities such as the WSSRAP operating under previously issued permits will not have to meet new quantification application requirements for existing permitted outfalls until they apply for renewal. Application requirements may apply for unpermitted outfalls.

- The other application deals with erosion and sediment control for construction activities of over 5 acres. The construction application requirements are much less stringent and stress best management practice.

8.1.5 Description of Effluent Monitoring Program

The monitoring system is best shown in tabular form. Tables 8-2 through 8-5 summarize the permit requirements for both permits and all nine outfalls.

8.1.5.1 Routine Monitoring Requirements. As the tables indicate, the outfalls are sampled at various frequencies. The continuous discharge outfalls are sampled on a monthly or quarterly basis as they discharge. The batch discharge outfalls from the site and quarry water treatment plants are to be sampled and the effluent held until compliance with the permit standards is determined.

Several parameters in the tables show monitoring only, and no effluent standard is applied. The site has established goals for these parameters, especially those associated with the radiological parameters. These goals are based on current NPDES permits and grouped into three general classes.

The administration building sewage treatment plant outfall, NP-0006, involves treatment of a sanitary waste with little or no radioactive contamination. The permit requirements are typical of a domestic treatment facility with discharge to an intermittent stream. The requirements are considered a high level of treatment: BOD 10 mg/l, and TSS 15 mg/l. Other nonradioactive sanitary wastewater generated on the site would be expected to meet these requirements. Non-radioactive is defined in the table as water containing less than the proposed drinking water standard for uranium of 30 pCi/l.

The stormwater outfall permit requirements have been established to monitor the rain-induced discharges and ensure the MDNR that the waters are rain-induced, and not seepage from one of the more contaminated sources. The site areas are being evaluated for future stormwater permit application requirements. The contamination levels in stormwater are highly variable, but considered as below the correction level because the annual average is historically less than the DOEs derived concentration guideline (DCG) for natural uranium of 600 pCi/l. The waters have contacted contaminated soil or material, but have not become contaminated enough to warrant in-plant treatment. The primary contaminant encountered in the surface water is sediment derived from erosion occurring during overland or channel flow. This process has been occurring for years but has been minimized by natural vegetation. The only imposed standard deals with controlling erosion and sediment during remedial activities: settleable solids 1 ml/l/hr after the Record of Decision, total suspended solids (if no erosion control) 50 mg/l, and monitoring for other parameters including uranium. Stormwater discharge levels for uranium have been monitored over a significant time and vary considerably. The established goal for rain-induced discharges is that they discharge no water that exceeds historic levels. New or additional contaminant controls must also meet the DCG of 600 pCi/l natural uranium established by DOE Order 5400.5.

The contaminated water in the quarry sump, raffinate pits, and potentially in other miscellaneous waters requires treatment to the high levels shown in Table 8-3. The high levels of treatment imposed by the permit are due to the desire by the State to meet standards associated with potential contamination of groundwater. Although the DOE goal for uranium is to discharge less than the DCG, the treatment required to remove the non-radioactive contamination allows for a significantly lower goal for these discharges. The lower level is based on the as-low-as-reasonably-achievable (ALARA) concept that showed by calculation that since a high level of treatment is required for levels above 600 pCi/l, treatment to a goal of 30 pCi/l and not to exceed 100 pCi/l is cost effective. This 30 pCi/l level has recently been proposed by the EPA as the drinking water standard for uranium.

8.1.5.2 Intermittent Monitoring Requirements. The DOE has agreed to additional monitoring associated with the site and quarry water treatment plants in response to regulatory and public concerns. Concern over a negative effect on the Missouri River led to additional water monitoring that will be conducted in the river during discharge of each batch of treated effluent. In-stream monitoring locations are shown on Figure 8-2 and include a location upstream of the quarry outfall (SW-1011); between the quarry outfall and the southeast drainage (SW-1012); downstream of both outfalls (SW-1013); and at the water intake for the Howard Bend WTP-St. Louis City-River Mile 37 (SW-1015). Radiological parameters (expressed as activity per liter) are required for in-stream monitoring and include: gross alpha, gross beta, uranium, Ra-226, Ra-228, Th-230, and Th-232.

The southeast drainageway, which receives the site effluent at its upper end, is a vicinity property and contains some areas of contaminated sediment. To gain knowledge of the contamination that is resuspended by the effluent flow down the drainageway, the outfall parameters for the site water treatment plant will also be analyzed just prior to entry to the river (SW-5311).

River sediment will be collected semiannually from the two locations shown on Figure 8-2, and analyzed for total uranium. Terrestrial and aquatic flora will be sampled from the river and levee areas upstream and downstream of the discharge point and analyzed for total uranium.

WET screens are required for the treatment plant effluent on a quarterly basis. Representative samples will be obtained from effluent ponds and used to perform the toxicity analysis on fish (pimephales), as described in the special conditions of the NPDES permit.

Po-210, Ac-227, and radon will be monitored semiannually for the quarry water treatment plant effluent. Preoperational monitoring for these parameters will be performed on the quarry sump water.

8.1.5.3 Upsystem Source Identification Needs. Sources of contamination occur upsystem of the three main stormwater discharges. These main discharges are the Frog Pond weir, NP-0002, Ash Pond weir, NP-0003 and the southeast drainage weir, NP-0005. Drainage facilities above each of these outfalls have an influence on the character of the discharges that is not fully understood. The variability of these discharges can best be determined by a concerted effort to monitor the upsystem facilities. This understanding will be more important as the new regulations are implemented and as more construction takes place on the site.

Additional sites that require investigation are not fully developed at this time. A full development will be presented in the *WSSRAPs Surface Water Protection Program Management Plan* that will be completed in early 1992. Certain locations are being considered for monthly monitoring; these include: Frog Pond, Ash Pond, Ash Pond diversion pond and outfall, the material staging area (MSA) pond, and the siltation basin (SB) pond. Other candidate locations may include periodic monitoring of the nonpermitted outfalls and some of the water entering the site.

The parameters needed to understand the contaminant sources do not include the full list of parameters needed for permit requirements. Flow estimates, uranium, and nitrate concentrations will provide the necessary information for preliminary evaluations. Periodic scans using an expanded list of parameters may be of value for baseline information as remediation progresses.

8.1.6 Stormwater Requirements and Needs

8.1.6.1 Current Erosion and Sediment Control Requirements. Permits for both the site and quarry place limitations on total suspended solids and pH levels for runoff from material storage or construction areas. If this runoff is not treated in a facility designed, constructed, and operated to treat the volume of water associated with a 10-yr, 24-hr rainfall event, the total suspended solids must not exceed 50 mg/l and the pH must remain in the range of 6.0 to 9.0 standard units at the outfalls.

In order to evaluate the effectiveness of erosion control measures, the DOE/Project Management Contractor (PMC) will periodically collect surface water samples adjacent to construction or material storage areas for analysis of pH and total suspended solids. Total suspended solids and pH measurements from the permitted outfalls are reported to MDNR in the regular discharge monitoring report.

8.1.6.2 Future Characterization Data. The new regulations require stormwater characterization data be obtained in a prescribed manner. Specific methods are:

- Grab samples are required for pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform, and fecal streptococcus.

- All samples from stormwater discharges shall be taken from the discharge resulting from a precipitation event of 0.1 in. and at least 72 hr from the previously measurable event.

- A flow weighted composite shall be taken for either the total discharge or the first 3 hr of discharge. The weighted sample should be taken with a continuous sampler or based on three grabbed aliquots per hour separated by a minimum of 15 min.

- Only one analysis is required for the composite. The grabbed aliquot taken in the first 30 min of the discharge shall be analyzed separately.

- A minimum of one grab sample may be taken in impoundments with retention greater than 24 hr.

- All samples shall be analyzed by methods approved under 40 CFR part 136 where applicable.

8.1.6.3 Reapplication Data

The collection of characterization data is needed for the reapplication and approval of current permits using the new sampling and quantification procedures. These activities will begin immediately to ensure adequate data for reapplication. The program needed to accomplish the activity includes three documents.

Surface Water Protection Program Management Plan -- The plan will describe the regulations, orders, and procedures governing the management of the site surface water. Transport, storage, treatment, and discharge of surface water will all be covered by the plan.

Site Hydrology Report -- The report will delineate the site watershed units, present the precipitation and flow data, and coordinate these data to develop runoff coefficients and predict surface water movement.

Stormwater Characterization Report -- The first part of this report will provide chemical data for the stormwater discharge using discrete samplers combined with flow information. The data will be used to develop sampling procedures to best describe the character of the discharges. These procedures will then be used to chemically characterize the discharges using the parameters required for the application.

Additional sampling of tributaries upstream of the regulated outfalls will also be needed to fully understand the discharge character. The characterization of the discharge may require a minimum of three storm events at each of the regulated points. The chemical characterization of the stormwater may also require sampling of a minimum of three events at each point. Additional details will be provided in a sampling plan.

8.1.6.4 Construction Application Data. Documentation to satisfy the application requirements for permits must be obtained because of the construction on the site. Most of the required data is currently being developed as part of other activities of the site and no sampling is needed to satisfy these requirements. Current studies will develop and detail the design requirements for controlling surface water for the site during and after the construction. A *Surface Water and Erosion Control Report* will propose the best combination of facilities that will constitute the best management practice (BMP) for the site. The presentation of this material to the MDNR will satisfy the relevant and appropriate requirements for the application. A formal application is not anticipated because of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) regulations, however the spirit of the regulations is evident through the use of best management practices.

8.2 Airborne Effluent and Environmental Surveillance Program

This section documents the rationale and requirements of the programs that will be implemented to monitor airborne emissions from the WSSRAP and to evaluate the impacts of those emissions on the public and the environment. The WSSRAP has two diffuse sources of airborne radiological emissions; the WSCP/WSRP, and the WSQ. Emissions from these sources and the estimated exposures are predicted to be low. The emissions monitoring program is tailored to be commensurate with the low potential for exposure.

8.2.1 Source Assessment

As required by DOE guidance, an assessment of the two diffuse sources was conducted. The assessment included documenting the different radionuclides that could potentially be released from the sources and their concentrations. In addition, the assessment addressed the factors that could potentially contribute to the suspension of contaminants. The assessment provided a basis for the airborne emissions monitoring program and ensured that the design would provide timely, representative, and adequately sensitive monitoring results.

8.2.1.1 Weldon Spring Quarry Source Assessment. The WSQ diffuse source is a 9-acre limestone quarry located approximately 4 mi south-southwest of the WSCP/WSRP area. The WSQ is essentially in a closed basin; surface water within the rim flows to the quarry floor and into a pond which covers approximately 0.5 acre. The WSQ was used as a disposal area for dinitrotoluene (DNT), trinitrotoluene (TNT) process waste, uranium, radium and thorium residues and the associated daughter products from on-site and off-site processing of uranium, and building rubble and soils from the demolition of a uranium processing facility in St. Louis. Airborne emissions from the quarry result from the wind blown resuspension of radioactive particulates from quarry soils and resuspension of radioactive particulates from activities at the WSQ such as the operation of heavy equipment and the excavation of soils. In addition, there are also airborne releases from the WSQ due to the decay of Ra-224 and Ra-226, daughters of Th-232 and U-238, into Rn-220 (thoron gas) and Rn-222 (radon gas).

Characterization of the WSQ soils has been completed in support of the WSQ Remedial Investigation/Feasibility Study (RI/FS). The radiological contaminants in the WSQ are uranium and thorium and their respective daughters. Concentrations range from 3.0 pCi/g to 1600 pCi/g U-238, <1.0 pCi/g to 2780 pCi/g Ra-226, 0.7 pCi/g to 36 pCi/g Th-232, <1.0 pCi/g to 2200 pCi/g Ra-228, and <1.0 pCi/g to 6800 pCi/g Th-230. A study is being conducted to determine the lung solubility class of WSQ bulk waste. Until the lung solubility classes have been determined, the most restrictive solubility classes will be assumed for uranium and thorium in the bulk waste.

Statistical evaluation of the results from effluent monitoring at the WSQ during 1990 indicated the results from one of the air particulate monitors and four of the radon track etch detectors were greater than background. The calculated effective dose equivalent to a hypothetical maximally exposed individual from the airborne emissions from the WSQ was 3.3 mrem (MKF and JEG 1991d). The 3.3 mrem dose calculated for the hypothetical individual from the airborne inhalation pathway was almost exclusively due to radon emissions. The assumptions that were used to calculate the dose were conservative. It was assumed that the daughter equilibrium ratio at Highway 94, where the individual walked twice daily, was 50% and that the concentration of radon at Highway 94 was the same as the concentration measured within the WSQ controlled area. These conservative assumptions resulted in a higher calculated dose to the hypothetical individual than would have otherwise been calculated using a less conservative daughter equilibrium ratio and a computer model to estimate the concentration at Highway 94.

Excavation of soils and placement of contaminated materials from remediation of the WSQ water treatment plant area are believed to be responsible for the above background air particulate monitoring results. These activities are similar to the activities that will occur during 1992. However, beginning in August of 1992, soils and bulk waste will be excavated within the WSQ that have significantly higher concentrations of radiological contaminants. Engineering controls will be used during bulk waste removal to restrict the release of airborne particulates from the WSQ during excavation of soils and bulk waste removal. In the *Feasibility Study for Management of the Bulk Waste at the Weldon Spring Quarry* (ANL 1990a) the dose estimate from airborne radioactive particulates for a hypothetical individual who walked along Highway 94 twice a day, during the 1.25 years that will be required to remove the bulk waste, was 1.3 mrem. The dose estimate calculated for a nearby resident with a assumed 100% occupancy time during the 1.25 years was 0.18 mrem.

In order to remove the bulk waste from the WSQ, the sump will have to be dewatered. The water that will be removed from the sump will be treated and released from a water treatment plant that is adjacent to the WSQ. Although the potential for airborne emission from the water treatment plant is small, there is some potential for the release of radioactive airborne emissions at one stage during operation of a filter press. The filter press will be housed in a small building. The filter press will also have a metal shroud to minimize emission within the building. Finally, the building will be ventilated with a high efficiency particulate air (HEPA) filter system to minimize releases to the environment. No above background radioactive emissions are expected from the operation of the WSQ water treatment plant.

Radon concentrations measured at the WSQ have historically been above background because the radium concentrations in WSQ wastes are typically higher than other areas and because the WSQ is a large depression in the terrain with side walls ranging from 10 ft to 50 ft high. In conjunction with stable meteorological conditions, this tends to trap emanating radon within the quarry and raises the concentrations at the WSQ. During 1992 the bulk waste will begin to be removed from the WSQ. Evaluation of the potential emissions of radon during the excavation of the bulk waste was also done in the feasibility study. The results of the study indicate that a dose of 1.0 mrem would be received by the hypothetical individual who walked along Highway 94 twice a day for 1.25 years. Although the dose estimate in the feasibility study is lower than the calculated dose to the hypothetical maximally exposed individual from airborne emissions during 1990, it is based on more realistic assumptions. A daughter equilibrium ratio of 10% was assumed based on measured radon and radon daughter concentrations taken during 1989 (Haroun et al 1990), and the concentration at Highway 94 was calculated using the computer model MILDOSE (Strenge and Bander 1981) which was modified to more accurately assess airborne concentrations resulting from releases from large areas (Yuan et al. 1989). The dose calculated for a nearby resident in the feasibility study was 2.3 mrem.

8.2.1.2 WSCP/WSRP Source Assessment. The WSCP/WSRP diffuse source encompasses 217 acres on which 33 buildings and four raffinate pits are located. Airborne emissions from the WSCP/WSRP result from the windblown resuspension of radioactive particulates from site soils and chemical plant buildings, and resuspension of radioactive particulates from site operations such as building demolition, and soil excavation. In addition, there are airborne emissions from the WSCP/WSRP due to the transformation of Ra-224, Ra-226 daughters of Th-232 and U-238, into Rn-220 (thoron gas) and Rn-222 (radon gas). Because the site is not an operating facility there are no point sources.

Characterization of the WSCP/WSRP buildings and soils have been completed in support of the site RI/FS. Radiological contaminants in the WSCP buildings are uranium, thorium, and the respective daughters. Concentrations in bulk samples collected from the WSCP buildings range from background levels to 1000 pCi/g U-238, 17 pCi/g Ra-226, 2682 pCi/g Ra-228, and 250 pCi/g Th-230. As at the WSQ, a lung solubility study is being conducted using materials from the WSCP/WSRP. Bulk samples from process buildings and the raffinate pits have been collected. Until the lung solubility classes have been determined, the most restrictive solubility classes will be assumed for thorium and uranium.

The site soils characterization also indicates that the contaminants in the soils are uranium and thorium and their associated daughters. Most of the 217 acres of the WSCP/WSRP have above background concentrations of uranium (>1 pCi/g). Concentrations range from 0.3 pCi/g to 2,259 pCi/g U-238, 0.6 pCi/g to 452 pCi/g Ra-228, and 0.3 pCi/g to 123 pCi/g Th-230.

In the past several years statistical evaluation of the results from effluent monitoring and environmental surveillance monitoring at the WSCP/WSRP has indicated that there is no reason to suspect at the 95% confidence level that the results were greater than background (i.e., no above background exposure to the public from WSCP/WSRP operations has occurred). Activities that will be performed during 1992 are similar to those that were performed in previous years, such as excavation of low level radiologically contaminated soils and building demolition. Although building demolition during 1992 includes buildings that have significantly higher concentrations of contaminants than those that have been demolished previously, additional engineering controls will be used to control emissions. These engineering controls include cleaning or removing loose contamination (i.e., dust or dirt) from the internal and external surfaces of the building and equipment prior to the start of demolition. In addition, water will be used during demolition to control dust emissions.

As mentioned in the WSQ source assessment, the bulk waste from the WSQ is expected to begin being placed at the temporary storage area (TSA) during August of 1992. Engineering controls such as the use of water to control airborne particulate emissions will also be used at the TSA. Radon gas emissions due to the higher radium concentrations in the bulk waste will be minimized through the use of an attenuating cover material. In the *Feasibility Study for Management of the Bulk Waste at the Weldon Spring Quarry* (ANL 1990a) a dose estimate for airborne emissions from the bulk waste at the TSA was calculated. In the study a dose estimate was calculated for a worker in an on-site office building and a student at Francis Howell High School. The calculated dose to the office worker was 0.08 mrem from radon, and 0.84 mrem from radioactive particulates for a total of 0.92 mrem. The calculated dose for the student was 0.05 mrem from radon, and 0.05 mrem from radioactive airborne particulates for a total of 0.1 mrem.

8.2.2 Airborne Monitoring Programs

To effectively monitor the two WSSRAP diffuse sources that have been described, three air monitoring programs will be utilized; site specific monitoring, perimeter monitoring, and critical receptor monitoring. These three programs are designed to meet the requirements for airborne effluent monitoring and environmental surveillance as specified in the *Environmental Regulatory Guide for Radioactive Effluent Monitoring and Environmental Surveillance* (DOE 1990) and DOE Orders 5400.1 and 5400.5.

The location, equipment, sampling time, minimum detection levels, accuracy, and investigation levels will be discussed in the site specific, site perimeter, and critical receptor monitoring program sections. In addition, sample heights, proximity to obstructions, and linear flow rate will also be discussed in the individual monitoring program sections.

8.2.2.1 Site Specific Monitoring Program. As mentioned in the WSCP/WSRP source assessment, the large WSCP/WSRP diffuse source is made up of a number of smaller diffuse sources that include wind blown resuspension of radioactive particulates from contaminated soils and buildings, and resuspension of radioactive particulates due to site remediation activities such as building demolition and excavation of soils. Although there is some potential for resuspension of radioactive particulates due to natural meteorological occurrences, it is small compared to the potential for site remediation activities to resuspend radioactive air particulates. In order to assess the contribution of site remediation activities to the total airborne emissions from the WSCP/WSRP, site specific monitoring will be utilized. Site specific monitoring will also be used at the WSQ to supplement data from the WSQ perimeter monitors. Site specific monitoring will use mobile air particulate samplers placed upwind and downwind from smaller diffuse sources.

Site specific monitoring, in addition to providing data concerning the contribution of specific activities to the total airborne inventory, will provide faster feed back concerning the effectiveness of engineering controls and data concerning dispersion patterns. Filters from site-specific monitors will be collected on a daily basis as compared to weekly for the perimeter samplers, which means data can be obtained as much as six days sooner. In addition, by varying the distances and configurations of the samplers, valuable information concerning dispersion patterns can be obtained for the WSSRAP.

During demolition of a building within the WSCP/WSRP area, for example, mobile air particulate samplers would be used to monitor airborne emissions from the specific activity. At least four monitors would be used, one upwind and three downwind from the activities. Placement of the samplers would be based on current meteorological conditions provided by the site meteorological station and experience gained from previous placement of samplers. During 1991, site specific monitoring was initiated during the demolition of four non-process buildings. The samplers were placed at various distances and configurations with respect to the source. The experience and data gained in 1991, and as 1992 progresses, will be used to assess the best placement for the samplers.

The air samplers will be placed in areas, when possible, that are free from obstructions or conditions that could effect the air sampling results. When possible, the air samplers are two times the distance from one obstruction or structure as the obstruction or structure is high (i.e., an air sampler would be placed 10 ft from a 5 ft tall tree). In addition, the samplers will be placed if possible, in areas that do not have turbulent air conditions, such as near busy roads, or active equipment.

Site specific monitoring will be utilized during remediation activities at the WSQ. Monitors will be placed just outside the work areas based on the current meteorological conditions. Site specific monitoring will be used to assess airborne emissions from specific activities and areas within the WSQ.

Equipment that will be used for site specific monitoring includes a portable air particulate sampler with a filter holder and a vacuum pump, a mass flow meter, filter, portable power supply, and air sampler stand.

There are two types of portable air samplers that will be used for site specific air monitoring; high volume self-adjusting brush motor air blower, and low volume carbon vaned oil-less vacuum pumps. The high volume samplers are generally operated at approximately 400 l/min, and the low volume pumps at approximately 40 l/min. The linear flow rates for the high and low volume air samplers, volume sampled per unit time, divided by the filter area, is 48 m/min and 23 m/min, respectively.

A mass flow meter which is calibrated in a NIST traceable wind tunnel will be used to set the flow rates of the portable air monitors at the beginning of each sampling period. The mass flow meter electronically compensates for temperature and pressure to read in standard liters per minute (sl/min, a liter of air at 0°C and barometric pressure of 76 cm Hg). The mass flow meter will also be used to check flow rates at the end of the sampling period.

The filters that will be used for low-volume samplers are a mixed cellulose esters membrane. These filters have a pore size of 0.8 μm and are 47 mm in diameter. The manufacturer states that the filter media retains 99.98% of dioclylphalate particles with an aerodynamic mean diameter of 0.3 μm at 32 l/min across a 100 cm^2 surface area. Filters for the high volume samplers are 102 mm in diameter glass fiber filters which retain 99.98% of dioclglphate particles with an aerodynamic mean diameter of 0.3 μm. The samplers will be placed on portable stands at a height of approximately 1 m off the ground. The air samplers will be placed at 1 m rather than 2 m as specified by the EPA due to the weight of the pumps and the safety problems that would be brought about by placing the pumps at 2 m off the ground. The 2 m height would require personnel to lift the pumps, which are relatively heavy and will be moved frequently, above their heads. In addition, the stands would have a high center of gravity, making the stands susceptible to tipping in strong winds.

Because there is presently no electrical service in the controlled area of the WSCP/WSRP where the portable air samplers will generally be used, portable generators will be used to power the air samplers.

The minimum detectable concentration (MDC) that will typically be achieved during site specific monitoring is approximately 5.0E-14 μCi/ml. Because work activities may not always have a duration long enough to collect a large sample volume, a sample MDC may be higher than the typical MDC of 5.0E-14 μCi/ml. In addition, the high-volume, site-specific samplers, due to the higher flow rates, can collect a large enough sample volume so that a sample MDC could be significantly lower than the typical MDC. Whenever possible a large sample volume will be collected in order to reduce the MDC.

The total typical accuracy or uncertainity associated with a site perimeter air particulate sample, at a concentration of 1E-15 μCi/ml, is 1.0×10^{-16} μCi/ml. The total sample accuracy or uncertainty is dependent on the uncertainty associated with a number of sources which include the volume sampled, detector calibration, uncertainties with efficiency and background count rate, and sample count rate.

After samples are collected, the filters will be stored for a minimum of 72 hr before they are counted to allow for decay of the short lived radon and thoron decay products. The activity of the samples will then be counted on an alpha-scintillation detector or a gas-flow proportional counter. Counting times for the alpha scintillation detector and the gas flow proportional counter will generally be 60 min. Counting times may be longer in order to achieve a lower MDC.

The investigation level which will be implemented for the site specific monitoring will be a downwind measured concentration of two times the up-wind concentration. The investigation will attempt to determine the source of the airborne contamination.

The Quality Control (QC) procedures that will be implemented as part of the site- specific monitoring program include the calibration of instruments, source and background counts, recounts of samples, and review of documentation. The QC procedures are intended to ensure the accuracy and validity of the data.

Calibration will be required for the alpha-scintillation and gas-flow proportional detectors, and the mass flow meter. The alpha-scintillation detector will be calibrated a minimum of every six months using NIST traceable radioactive sources. The gas-flow proportional counter will be calibrated when repairs are made to the detector. The mass flow meter will be calibrated on an annual basis by the manufacturer in a NIST traceable wind tunnel. In addition, the portable airborne particulate samplers will be leak tested on an annual basis to ensure that the measured volume of air is passing through the sample collection filter.

Daily source and background counts will be made on the alpha-scintillation and gas- flow proportional detectors. The daily source and background count results are compared to the calibration results. If daily checks are within three standard deviations when compared to results obtained during calibration, instruments will be put into service. Instruments failing the daily background check will be taken out of service as described in the applicable WSSRAP standard operating procedure (SOP).

At least one in 20 samples will be recounted and the results compared to the initial count results. The precision between the two sample counts will be determined and the results kept on file.

A review of the sample documentation and calculations by an individual other than the sampler will be required as part of the QC procedure. The reviewer will be responsible for ensuring that the documentation is complete and the calculations correct.

8.2.2.2 Site Perimeter Monitoring. In order to monitor the airborne emissions from the two large diffuse sources, the WSCP/WSRP and the WSQ, which encompass large areas of soils having above background radionuclide concentrations, a perimeter monitoring program will be utilized. The program will require the use of eight air particulate monitors and radon track etch detectors at permanent locations. The monitors will be used in conjunction with site specific monitoring to estimate the total airborne emissions that leave the two diffuse sources. The use of air monitors at the WSCP/WSRP and WSQ perimeter, in conjunction with site specific monitoring, is the most effective way to monitor airborne emissions from the WSS. The sources described in the WSCP/WSRP and WSQ source assessment are essentially ground sources. Sources such as stacks or vents that release radioactive material at a significant distance from the ground have the highest measured concentrations at ground level some distance from the source. This occurs because it takes time for the material to reach the ground, and as the material falls, it is driven from the source by the wind. Ground sources however, have the highest concentration measured at the ground level at points closest to the source. As a result, the highest concentrations that leave the WSCP/WSRP and WSQ are at the perimeters.

There will be five perimeter radioactive air particulate monitoring stations at the WSCP/WSRP (Figure 7-1). The WSCP/WSRP perimeter monitors are generally equally spaced along the perimeter fence with distances ranging from approximately 2,079 ft to 2,970 ft. Because the potential for airborne emissions from the WSCP/WSRP is low, any airborne emissions that do occur will be intermittent and have low concentrations. The use of five perimeter monitors is commensurate with the potential for an exposure to a member of the general public.

There will be three perimeter radioactive particulate monitoring stations at the WSQ (Figure 7-3). The WSQ perimeter radioactive air particulate monitoring stations are located on the southeastern end of the WSQ and at the southern edge of water treatment plant area adjacent to the WSQ. The two sampling locations at the southeast end of the WSQ and the sampling location at the southern end of the water treatment plant facility represent areas that have the highest potential for airborne emissions. The prevailing winds in the vicinity of the WSQ are from the south and southwest during summer and fall, and from the north, northwest, and west during spring and winter. The WSQ is surrounded by steep cliffs on the north, east, and south and is accessible by relatively flat land only from the west. The third monitor will be used to monitor any potential emissions from the flat entrance area at the west end of the WSQ during remediation activities.

There will be 10 radon monitoring stations at the WSCP/WSRP perimeter (Figure 7-1) placed approximately 2,310 ft to 6,600 ft from one another. Due to the characteristics of the WSCP/WSRP diffuse radon source, the density of radon monitoring stations around the perimeter will be commensurate with the potential for causing an exposure from radon to a member of the general public. Remediation of the WSCP/WSRP is not expected to increase radon emissions, but some increase may occur during the transfer of bulk waste from the WSQ to the TSA which is located within this area. The TSA will be monitored for radon at the TSA perimeter. Five monitoring stations will be used at the TSA perimeter (Figure 7-2). The stations will be placed at intervals of 420 ft to 780 ft from one another. Because the waste that will be transferred from the WSQ to the TSA has higher concentrations than the WSCP/WSRP soils, there is higher potential for radon emissions from the TSA than from WSCP/WSRP. As a result, the distances between radon monitoring stations at the TSA will be less than WSCP/WSRP station separation.

An effective dose equivalent of 0.08 mrem was calculated at the nearest WSCP/WSRP critical receptor with the highest potential for an exposure to a member of the general public as a result of radon emission. Therefore the 10 radon monitoring stations at the WSCP/WSRP perimeter will be sufficient to monitor potential radon emissions.

There will be eight radon monitoring stations on the WSQ perimeter (Figure 7-3). The radon monitoring stations at the WSQ are approximately 264 ft to 825 ft apart. The distance between monitoring stations at the WSQ is less than at the WSCP/WSRP because of the higher radium concentration at the WSQ and because the WSQ is a large depression in the terrain with side walls ranging from 10 ft to 50 ft high. This, in conjunction with stable meteorological conditions, tends to trap emanating radon within the WSQ and raises the concentrations along the WSQ perimeter. As a result there is higher potential for radon emissions from the WSQ than from the WSCP/WSRP, and thus the distance between stations at the WSQ is smaller.

The number of radioactive air particulate and radon monitoring stations at the WSCP/WSRP and WSQ is in proportion to the potential for emissions from the sources. In addition, the use of site specific monitoring will allow monitors to be placed such that the density of monitors will be increased in the direction dictated by the current meteorological conditions.

Equipment for the site perimeter monitoring program includes low volume air particulate samplers, continuous radon-gas and radon-daughter monitors, a mass flow meter, scintillation detectors, a gas-flow proportional detector, filters, and radon track etch detectors.

The low volume air particulate samplers at the five WSCP/WSRP site perimeter locations are self-adjusting, twin-diaphragm, oil-less air pumps. At the two WSQ perimeter monitoring locations self adjusting, carbon vaned, oil-less air pumps are utilized. Each sampler will be mounted in a weather-protective housing with a 110-volt outlet and a thermostat-controlled fan for cooling. Each sampler will have an hour meter to document the operational periods. Samplers will also have a flow meter, vacuum gauges, and be equipped with a regulator to maintain a constant flow rate.

The continuous radon gas and radon daughter monitors (Figures 7-1 and 7-3) are portable, fully automated instruments capable of continuously monitoring for radon, and radon and thoron daughters. The radon detectors contain a 5 in. diameter tube that is optically coupled to a 3 liter Lucas Cell coated with silver activated zinc sulphide to detect radon gas. The working level monitor uses a ruggedized silicon barrier diode detector which is used to detect radon and thoron daughters deposited on a membrane filter with a 0.45 μm pore size. The continuous radon and working level monitors have internal data storage capabilities. The data will be retrieved from the sampler locations by downloading the data from the samplers to a portable computer. The sensitivities of the continuous radon and radon daughter monitors are 1.0 pCi/l and 1.0 mWL. The manufacture stated accuracy for the continuous radon and radon daughter monitors is within $\pm 10\%$ of the measured concentration.

A mass flow meter is used to set and measure the flow rate of the low volume air particulate samplers. The low volume air particulate samplers will be run continuously at a flow rate of approximately 40 l/min (1.4 cu ft/min) with weekly filter replacement. Prior to changing the filter each week, the flow rate is measured with the mass flow meter which electronically corrects for pressure and temperature to read in standard liters per minute. After the filter is changed the flow rate will be adjusted on an as-needed basis to 40 l/min. The starting flow rate of 40 l/min is then averaged with the ending flow rate, and the average flow rate used to calculate the total volume of air sampled. If the flow rate changes by more than 20% during the sampling period, the monitor will be evaluated to determine if service is required. The data will be flagged and used for qualitative purposes only. The linear flow rate for the perimeter low volume air particulate samplers is 23 m/min at 40 l/min. The site perimeter airborne particulate and continuous radon and radon daughter monitors will be leak tested on an annual basis. Leak testing will be done to ensure that the measured volume of air passed through the filters or detection system.

The filters used to monitor the site perimeter are the same mixed cellulose ester filters used for site-specific monitoring. The filters are 47 mm in diameter, have a pore size of 0.8 μm and retain 99.98% of dioclyphalate particles with an aerodynamic mean diameter of 0.3 μm.

The perimeter air particulate samplers will be placed at approximately 2 m above the ground. The radon track etch detectors and the continuous radon and radon daughter monitors will be placed approximately 1 m above the ground, respectively. The locations where samplers, detectors, and monitors will be placed are free from unusual localized effects or other conditions (e.g., in proximity to a large building, vehicular traffic, or trees) that could result in artificially high or low concentrations with the exceptions of the WSQ perimeter monitors. Several of the WSQ perimeter monitoring stations are in proximity to trees. Because the trees serve as a natural barrier to airborne emissions, the trees will not be removed from the areas near the monitoring locations. In addition, due to the limited space available along the ridge at the southeastern perimeter of the WSQ, the stations cannot be moved to monitor the area and not be in proximity to the trees.

The radon detectors that will be deployed are track etch detectors that have a minimum sensitivity of 0.2 pCi/l. The vendor stated accuracy for the radon tract etch detectors is $\pm 25\%$ of the measured concentration. Data from 1990 indicated the average accuracy was $\pm 17\%$ with an average concentration of approximately 4.5 pCi/l which includes background. The detectors will be placed in pairs at each of the locations, and will be exchanged on a quarterly basis.

The air particulate filters will be counted to determine the gross alpha concentrations using an alpha scintillation detector or a gas flow proportional detector. The counting times for samples will in general be 60 min for the alpha scintillation detector and 5 min for the gas-flow proportional detector. The difference in count times between the alpha scintillation detectors and the gas-flow proportional detectors is due to differences in the background count rates and efficiencies of the instruments.

Each sample will be collected for a period long enough to ensure that a minimum detectable gross alpha concentration (MDC) of 1E-15 μCi/ml can be obtained. Because naturally occurring Po-210 and Pb-210 exist in the atmosphere at concentrations on the order of 2.5E-15 μCi/ml, obtaining a MDC less than 1E-15 μCi/ml is of little value due to the interference from Po-210 and Pb-210. An MDC of 1E-15 μCi/ml is sufficient to detect concentrations less than the derived concentration guides (DCGs) for radionuclides that are present at the WSS. The MDC is dependent on sample valume (sample time multiplied by the flow rate), the efficiency and background count rate of the instrument used to measure the activity on the filter, and the sample an dbackground count times.

The total typical accuracy or uncertainty associated with a site perimeter air particulate sample at a gross alpha concentration of 1E-15 μCi/ml is 1E-16 μCi/ml. The total sample accuracy or uncertainty is dependent on the uncertainty associated with the volume sampled, detector calibration uncertainties with the determination of detector efficiency, and detector background count rate, as well as the uncertainty associated with the sample count rate. Because difference detectors are used and because of variations in the other sources of uncertainty, the accuracy may vary, but 1E-16 μCi/ml represents a typical accuracy which would be achieved of a sample with a gross alpha concentration of 1E-15 μCi/ml.

The investigation levels that will be established for the perimeter air monitoring program are measured concentrations greater than the concentrations measured at the background station. The low volume air particulate sampler and the continuous radon and radon daughter monitor results will be compared to the background station results on a weekly basis. The radon track etch detectors will be compared to the background stations results on an annual basis.

The low volume air particulate samplers and continuous radon and radon daughter cumulative measured concentrations will be compared to the background station cumulative measured concentrations. The perimeter stations will be compared to the background station using a statistical test to identify locations that have weekly measured concentrations greater than background. If it is determined that the measured concentrations at a location are greater than the background station's measured concentrations, an investigation will be conducted in order to attempt to identify the source of above background concentrations.

Because the radon track etch detectors are collected on a quarterly basis, and as a result there are only four data points per year per location, the radon track etch detectors are compared to the background stations results only on an annual basis. Each location's monitoring results are compared to results from the background stations. If the results from a location are found to be statistically greater than the results from the background stations, an investigation will be conducted to determine the source of the above background concentrations, with the exception of the quarry monitoring stations which are historically greater than background because of the radiologically contaminated material that was placed in the quarry.

The QA/QC procedures for the low volume air particulate samplers are the same as those described for site specific monitoring.

The QA/QC procedures that will be implemented for the continuous radon gas and radon daughter monitors include calibration and source checks. The continuous radon gas and radon daughter monitor will be calibrated annually at the Technical Measurement Center at Grand Junction, Colorado.

The QA/QC procedures that will be employed for the perimeter radon track etch detectors include duplicates, spikes, chain-of-custody and laboratory authorization forms, field sheets, and review of vendor data. The pair of radon track etch detectors placed at each location will serve as duplicates. Three spikes, track etch detectors exposed to a known source, will be returned to the vendor for analysis on an annual basis. In addition, field sheets will be used during deployment and recovery of the radon track etch detectors to document detector locations and any unusual occurrences. Chain-of-custody and laboratory authorization forms will be filled out in accordance with the applicable SOP in order to track the radon track etch detectors. Finally, the data received from the vendor will be reviewed for any anomalies.

8.2.2.3 Critical Receptor Monitoring. The most accurate method of dose calculation at nearby receptor points is through the use of actual concentration measurements at these locations. Measurements from nearby receptor points or critical receptors will be an important element in determining the emissions from the WSCP/WSRP and the WSQ when used in connection with site-specific monitoring data and the perimeter air monitoring data. Critical receptors are defined as those locations at which individuals abide or reside where the highest potential off-site concentrations of radionuclides other than radon are likely to occur during remediation of the Weldon Spring site (WSS). The sites that were selected as critical receptors are located within 0.62 mi of the WSS where members of the public may spend at least 8 hr/d for a significant fraction of the year.

Critical receptor locations AP-2001, AP-4006, AP-4008, and AP-2005 (Figure 7-1) are strategically located to measure radioactive airborne emissions for the WSCP/WSRP at points where maximally exposed individuals reside or abide. Station AP-2001 is at the common boundary of the WSCP and Missouri Highway Maintenance Facility. Station AP-4008 is located at the Weldon Spring Army Reserve Training Area. Station AP-2005 is located between the WSCP and the WSSRAP administration building. Station AP-4011 (Figure 7-3) is located 165 ft from the nearest residence 0.12 mi west of the WSQ.

Other facilities (i.e., the St. Charles County Water Treatment Plant and the Weldon Spring Height subdivision) are located near the WSS; however, because of the greater distance and previous monitoring data from closer critical receptor locations indicating that there has been no reason to suspect above-background radioactive airborne concentrations with 95% confidence, these facilities are not considered critical receptors.

The critical receptor monitoring program will utilize high volume air samplers, low volume air samplers, and radon track etch detectors at all locations; and continuous radon and radon-daughter monitors at critical receptor locations AP-2005 and AP-4006, and the background station AP-4012. The high volume samplers have heavy duty, turbine-type blowers and feature an electronic controller that automatically adjusts the speed of the sampler to correct for variations in line voltage, temperature, pressure and filter loading. The low volume air samplers are the same samplers described in site perimeter air sampling. They have dual diaphragm air pumps at all locations with the exception of the critical receptor nearest the WSQ (Figure 7-3) that utilizes the carbon vaned air pump. The continuous radon and radon daughter monitors are the radon track etch detectors as described in the site perimeter air monitoring program.

Mass flow meters will be used as described in the perimeter monitoring program for the low volume air samplers. A mass flow meter will also be used to measure and set the flow rates of the high-volume air samplers. The low volume and high volume air particulate samplers will be run continuously at 40 l/min and 950 l/min respectively. The linear flow rates for the low volume and high volume air particulate samplers are 48 m/min and 23 m/min respectively. The low volume air samplers, and the high volume air samplers flow rate will be checked at the end of each week and then readjusted to the desired flow rate after the new filter is installed. The start and finish flow rates will be averaged, and the average flow rate used to calculate the total volume sampled. If the flow rate changes by more than 20% during the sampling period, the monitor will be evaluated to determine if service is required. The data will be flagged and used for qualitative purposes only.

The critical receptor high volume and low volume air particulate samplers will be leak tested on a annual basis. The leak testing will be used to ensure that the measured volume of air is passing through the sample collection filter.

The filters used for the low volume air samplers are the same filters used for site specific monitoring, and are 99.98% efficient in retaining 0.3 μm DOP particulates at a flow rate of 32 l/min across 100 cm^2. The high volume air samplers use 203 mm x 254 mm glass fiber filters that have a mean DOP efficiency of 99.99% for particulate diameters of 0.3 to 0.4 μm.

The low volume air particulate samplers and continuous radon and radon daughter monitors will be placed at the same height specified in the perimeter monitoring section. The high volume air particulate samplers have a sample height of approximately 2 m. In addition, the monitoring receptor stations will be located in proximity to unusual localized effects or other conditions (e.g., in proximity to a large building, vehicular traffic or trees) that could result in artificially high or low concentrations.

On a quarterly basis, each of the 13 weekly filters from high volume air particulate samplers at critical receptors and at the background station will be composited by location. The composite sample will then be dissolved and divided into three aliquots. The 18 composite samples (three aliquot from six sampler locations) will be analyzed for isotopic thorium, isotopic uranium, Ra-228, and Ra-226.

The filters from the low-volume air samplers will be collected on a weekly basis and analyzed for gross alpha concentrations using the same procedure described in the perimeter air monitoring program. The data stored in the continuous radon-gas and radon-daughter monitors will be collected weekly as described in the perimeter air monitoring program.

The investigation level for the critical receptor monitoring locations will be concentrations greater than background concentrations. The monitoring results from each location will be compared to the background stations location using a statistical test. If a station is found to be statistically different than background, an investigation to attempt to determine the source of the above background airborne radioactive material will be conducted.

The quality control procedures for the low volume air samplers and the continuous radon-gas and radon-daughter monitors will be the same as those described in the perimeter air monitoring program. The quality control program for the high volume air samplers will include spikes, duplicates, and blanks.

With each group of high volume sampler filters sent for radiochemical analysis, two filters will be spiked with known activities of Th-230, and two filters will be spiked with known activities of natural uranium (U-238, U-235 and U-234 in natural activity ratios). Since each filter composite collected at critical receptor locations is split into thirds, these thirds will serve as duplicates.

Field blanks will be collected each week when filters are exchanged. A field blank is an unused filter that is taken with the technician in the field. In addition, an unused filter will be collected directly from the filter package. The two sets of blanks will also be composited and analyzed radiochemically. Results from the blank composite will be used to identify field or laboratory contamination of filters.

In addition to the system of spikes, duplicates, and blanks, the radioanalytical analyses will be evaluated for internal consistency. At the WSS, U-238 and U-234 are in secular equilibrium. Uranium concentrations on air filters should also be in equilibrium. When radioanalytical results are provided, the degree of equilibrium will be evaluated. In most cases, Th-228 and Ra-228 are also in equilibrium. Equality between these radionuclides will also be evaluated.

8.3 Asbestos Monitoring

During 1992, site perimeter air monitoring for asbestos will be routinely performed only when asbestos removal is taking place. Perimeter asbestos monitoring locations at the WSCP/WSRP and at the WSQ are the same as those used for radioactive air particulate monitoring (Figures 7-1 and 7-3). At least two perimeter asbestos monitoring stations at the WSQ and WSCP/WSRP will be used: one upwind and the other downwind from the asbestos removal activities. A determination of which monitoring stations to use will be based on current meteorological condition when asbestos removal begins. During asbestos removal activities at the WSCP/WSRP, an asbestos monitor will be placed at the Francis Howell High School in the same location as the radioactive air particulate monitoring station. Finally, asbestos monitoring will be performed inside and adjacent to asbestos removal work areas.

When asbestos removal activities are being performed at the WSS, daily asbestos monitoring will be performed in the immediate work area. Samples from the perimeter asbestos monitoring stations will be collected on a weekly basis. Samples from the Francis Howell High School monitoring station and from monitoring stations inside and adjacent to asbestos removal work areas will be collected on a daily basis.

9 ENVIRONMENTAL MONITORING PROGRAM ADMINISTRATION

This section describes the activities that will constitute much of the structure and substance of the environmental monitoring program at the site. Aspects of data management and presentation are discussed along with regulatory compliance and the performance of dose assessments. In addition, the performance of special studies that are outside the scope of this document, emergency preparedness, and changes in the scope of investigations are also addressed.

9.1 Data Analysis and Statistical Treatment

Proper data analysis and statistical treatment practices are essential to produce quality results from the effluent monitoring and environmental surveillance programs required by DOE 5400.1 and DOE 5400.5 and the *Regulatory Guide*. Therefore, it is necessary to develop a plan for implementing the following action items:

- Determining contaminant concentrations at each sampling location for each sampling period, and evaluating the accuracy and precision of those concentrations.
- Comparing the contaminant concentrations at each sampling location to previous concentration estimates at that point and to identify changes or inconsistencies in contaminant levels.
- Comparing the contaminant concentrations at each sampling location to the established limits for those contaminants.
- Comparing contaminant concentrations at single sampling locations or groups of locations to those at control (i.e., background) or other points and evaluating the reliability of those comparisons.

In order to ensure that environmental data are reviewed in a consistent manner and that appropriate and timely action is initiated when and if criteria are exceeded, the Weldon Spring Site Remedial Action Project (WSSRAP) has taken steps to establish investigation levels. The criteria applied by WSSRAP for defining the investigation levels for all environmental monitoring data (except asbestos) are described in several ES&H procedures. The procedures have been written to direct the WSSRAP staff in the evaluation of the monitoring data. These evaluations will determine whether data collected over the course of routine environmental monitoring programs exceed specific action levels and refer to an administrative procedure (still in draft form) which will define the general actions to be taken for eceedence of any criteria. These procedures include:

ES&H 4.6.4 - *Constant Flow Low Volume Air Sampler Operation and Air Sample Filter Handling*

ES&H 4.6.6 - *Constant Flow High Volume Air Sampler Operation and Air Sample Filter Handling*

ES&H 4.6.7 - *RGA-40 Radon Gas Monitor: Operation and Data Handling*

ES&H 4.9.3 - *Surface Water and Groundwater Data Review Procedure*

These procedures are intended to effectively address the U.S. Department of Energy (DOE) guidance criteria for determining investigation levels for environmental monitoring programs.

The statistical techniques used to evaluate and analyze the data will be designed with consideration for the characteristics of effluent and environmental data. These characteristics may include skewed distributions of time series data, high variability analytical results, large amounts of missing data, and data that are below analytical detection limits.

9.1.1 Summary of Data Analysis and Statistical Treatment Requirements

The following sections summarize the methods of data analysis and statistical treatment of the effluent and environmental data. Immediately upon receipt from the laboratory, all new data will be evaluated against the corresponding historical statistics and entered into the WSSRAP environmental database. Apparent outliers will only be excluded from use after investigation confirms that an error has been made in the sample collection, preparation, measurement, or data analysis process.

Data will be summarized using a range, variance, standard deviation, standard error, median, mean, and confidence interval about the mean. The confidence level of the data will be estimated by using blank and spike samples, and comparing the results of these analyses to the known concentrations. The precision of the data will be estimated by comparison to replicate samples.

9.1.2 Variability of Effluent and Environmental Data

The variability of the effluent data will determine the degree of precision and accuracy that can be achieved with the results. Careful design and execution of the monitoring program can substantially improve the quality of the effluent monitoring and environmental surveillance results.

9.1.2.1 Sources of Variability. Variability of data may arise from six sources; sampling errors, analytical errors, statistical counting variations, data recording errors, and temporal, and spatial variability between environmental samples. Variability due to sampling and recording errors can be controlled. However, variability due to the environment cannot be controlled and must be checked through statistical summaries.

9.1.2.2 Estimating Accuracy and Precision. The validation process will assess the accuracy and precision of each data set according to WSSRAP data validation procedure (RC-31a) using replicate samples. The *Annual Site Environmental Report* (ASER) will present the results of specific validated data points (10 percent of all environmental data collected) and will report the average and standard deviationof the accuracy and precision by data set, including parameter and media specific data points.

9.1.3 Summarization of Data and Testing For Outliers

In order to adequately analyze the environmental data, it must be summarized. Testing for outliers in new data sets also requires that historical data be statistically summarized. The following subsections describe statistical methods used to summarize the historical data.

9.1.3.1 Distribution Analysis. Most common statistical tests rely on the assumption that the data being tested follows a normal distribution. However, this is not the case for most environmental data which generally follows a log-normal distribution. Therefore, all data sets containing 10 or more samples will be tested for distribution type and, if necessary, the appropriate transformation will be made prior to calculation of summary statistics. Alternatively, nonparametric hypothesis testing will be used.

9.1.3.2 Measures of Central Tendency. For normally distributed data with only a small number of extreme or less-than-detectable values, the arithmetic mean is the appropriate estimator of central tendency. When the data set contains large numbers of extreme values or concentrations below the analytical detection limits, the median, which is less sensitive to extreme values than the mean, will be used to summarize the data. Trimmed means or minimum variance unbiased estimators may also be used in these cases.

9.1.3.3 Measures of Dispersion. Dispersion in normally distributed data, without large numbers of outliers and less-than-detectable values, will be represented as a variance, standard deviation, standard error, or confidence interval. If a large number of extreme values are contained within a data set, the interquartile range and the median absolute deviation will be reported.

9.1.3.4 Less-Than-Detectable Values. An effort will be made to obtain uncensored radionuclide data. If nondetects (NDs) are reported, different techniques may be used depending on the percentage of NDs in the data set. For analyzing data sets with a small percentage of NDs, the special techniques described by Gilbert and Kinnison (1981) will be used. For data sets with a larger percentage of NDs, rank dependent or proportion type hypothesis testing will be used.

9.1.3.5 Testing for Outliers. Rosner's (1975) test for detecting outliers will be used when the data is normally distributed. If the data is log normally distributed, the test will be conducted on the log transformed data.

9.1.3.6 Elements of Good Practice. Procedures will be used to aid in the interpretation of the effluent monitoring data and improve the quality of the results from the program by helping to detect erroneous measurements. Comments on the quality of the samples taken will be entered into the data base with the sample contaminant concentration measurements. In addition to the data collected during the regular sampling program, field logs describing events that might affect contaminant concentrations will be reviewed and incorporated as appropriate.

9.1.4 Treatment of Significant Figures

Any calculations performed using the analytical data will follow the accepted rules for significant figures. Results of any calculations will not contain more significant figures than that of the least precise value used in the calculation.

9.1.5 Parent-Decay Product Relationships

The delays associated with sample collection to sample analysis are insignificant compared to the half-lives of the radionuclide present and routinely monitored at the WSS. Therefore, it is not necessary to take into account decay times when calculating parent-decay product relationships.

9.1.6 Comparisons to Regulatory or Administrative Control Standards and Control Data

One reason for obtaining reliable estimates of contaminant concentrations at the monitoring stations is to compare the values to regulatory or administrative control standards or values at control stations to determine whether action must be taken to reduce the contaminant levels in the effluents.

9.1.6.1 Single Concentration Measurements. Statistical tests are not appropriate for comparisons of single values, such as when a single radionuclide concentration measurement is compared to its regulatory limit. Single values can have a large associated uncertainty, and they are not necessarily an accurate representation of how well the facility is complying with the limit. Statistical summaries of groups of related samples will be used when possible. If single concentration measurements cannot be grouped, statistical tolerance limits will be used.

9.1.6.2 Groups of Measurements. Concentration estimates from groups of sampling locations will be compared using standard analysis of variance techniques when the data meet the underlying assumptions of those tests. Standard nonparametric statistical comparison techniques will be used when the assumptions of the parametric tests are not met by the data. Caution will be used when comparing groups of readings from single points over time, because of the likely strong autocorrelation in the time series of data.

9.2 Dose Calculations

This section is intended to provide a description of models, computer programs, input data, and data sources that will be used to assess accurate and realistic radiation doses to the population and to a hypothetical maximally exposed individual that could result from remediation activities at the WSSRAP. Environmental monitoring data will be used either as direct input data in dose calculations or, where appropriate, will serve as data input in exposure and dose models.

The results of the dose calculations will be reported in the *Annual Site Environmental Report* (ASER). The methodology used to calculate the exposure point concentration and estimate dose will also be documented in the ASER.

9.2.1 Surface Water and Groundwater Dose Calculations

The radiological dose assessment from groundwater and surface water will be accomplished by using data gathered from groundwater and surface water effluents monitoring and environmental surveillance monitoring programs. Site-specific monitoring data representing surface water and groundwater radionuclide concentrations will be used as input in the dose assessment calculation. This data will allow a more accurate assessment of doses to a maximally exposed individual and the population surrounding the WSS.

The exposure and dose assessment estimate will be conducted for both the general off-site population and a maximally exposed receptor. Intake variables for a given pathway will be selected to reflect a reasonable, realistic exposure mode.

The results from the surface water and groundwater effluent monitoring and environmental surveillance programs will be evaluated in the ASER for the potential to contribute a radiological dose to a member of the general public. If measured concentrations in surface water and groundwater effluent from the WSS exceed natural background concentrations with 95% confidence, an exposure scenario will be developed to assess the dose. Realistic ingestion rates and times will be assigned for a maximally exposed individual. A standard dose conversion factor will be assumed and referenced for the calculations.

9.2.2 Airborne Radiological Dose Calculations

The radiological dose assessment from airborne emissions will be conducted using environmental data as well as computer models. Exposures for critical receptors and hypothetical maximally exposed individuals will be determined through monitoring data. For sources where perimeter monitors indicate exceedance of background with 95% confidence, population dose estimates will be made by computer modeling. This would constitute a change over previous monitoring years when computer modeling was not utilized. The new site specific monitoring program, in conjunction with existing perimeter monitoring data will be used to obtain a more reliable source term. This will allow computer modeling to be used if necessary.

The computer models that will be considered for use in this dose assessment include AIRDOS PC, LTSAMP, and COMPLY. COMPLY and LTSAMP are computer models that have the capability to assess radiological dose from airborne emissions at distances less than 300 m. COMPLY is a U.S. Environmental Protection Agency (EPA) computer model designed mainly to model emissions from stacks or vents rather than large diffuse sources. LTSAMP is a computer model developed at the Uranium Mill Tailings Remedial Action (UMTRA) project to calculate doses from large diffuse sources.

Because of the diverse nature of the sources at the WSSRAP, any one of these programs or all three may be used to assess doses due to airborne emissions from the two WSSRAP sources. The use of LTSAMP would also be dependent on gaining approval from the U.S. Department of Energy (DOE) headquarters.

Those pathways that are complete and could realistically contribute to the dose to a member of the general public will be assessed and documented in the ASER. Justification for elimination of any pathways will also be provided in the ASER. Scenarios that reflect realistic but conservative assumptions will be developed for those pathways that could contribute to the dose to a member of the general public. Realistic occupancy times will be assumed for potentially exposed individuals. Standard breathing rates and dose conversion factors from the Federal Guidance Report No. 11 (Eckerman et al. 1988) will be used in the calculations.

9.3 Records and Reports

The WSSRAP recognizes numerous DOE orders, notices, and directives in addition to Federal, State, and local regulations. Since the WSS is a remedial action project, rather than an operating facility, the distinction between applicable and nonapplicable guidelines must be determined when interpreting these regulations. The project must comply with appropriate regulations, and ensure that reports are written and distributed in a timely manner and records are properly maintained.

9.3.1 Reports and Reporting

The following DOE Orders: Order 5000.3A, Order 5400.1, Order 5400.5, Order 5284.1B and Order 5484.1 govern activities at the WSS. These orders are described below in the following paragraphs.

DOE Order 5000.3A, *Occurrence Reporting and Processing of Operations Information*, is a system of reporting those occurrences listed in 5400.1, 5400.5, and 5484.1. Occurrences are categorized into nine groups such as environmental, personnel radiation protection, and divided into three categories in order of decreasing severity: emergencies, unusual occurrences, and off-normal occurrences.

DOE Order 5400.1, *General Environmental Protection Program*, requires that all DOE facilities comply with those Federal, State, and local environmental protection laws that are applicable. Both environmental occurrences and routine monitoring reporting are covered. WSSRAP has prepared an *Environmental Protection Program Implementation Plan* (EPPIP) (MKF and JEG 1991a) to meet the specific requirements of DOE Order 5400.1. Environmental occurrences will be reported as stated in DOE 5484.1 and DOE 5000.3 in accordance with WSSRAP procedures. Reports prepared by the WSSRAP include the *Environmental Monitoring Plan, Annual Site Environmental Report, Groundwater Protection Program Management Plan, Groundwater Monitoring Plan, Radioactive Effluent Information System and On-site Discharge Data Reports*, the *Quarterly Environmental Data Summary* and the *Environmental Protection Program Implementation Plan* (EPPIP).

The *Environmental Monitoring Plan* (EMP) details environmental and effluent sampling. The EMP is reviewed annually, as needed, and reissued at least every three years. The *Annual*

Site Environmental Report (ASER) presents data results and interprets these results, highlighting any unusual data. The ASER is produced annually (see Section 9.3.1.1). The *Groundwater Protection Program Management Plan* structures the groundwater program into a consistent program which facilitates periodic review. This plan is reviewed and updated annually. The *Groundwater Monitoring Plan* is taken directly from the EMP, with the focus on the groundwater monitoring program. The *Radiation Effluent Information System and On-site Discharge Data Report* is an annual report which consist of a letter and DOE form F 5821.1 which covers any releases from the site. The *Environmental Protection Program Implementation Plan* (EPPIP) as mentioned above outlines DOE Order 5400.1 as it applies to WSSRAP. This plan is updated annually and should be referred to for a complete and thorough listing of applicable regulations.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, states that Department of Energy facilities will adopt specific standards and requirements that will not allow undue risk from radiation to effect the public or the environment. The WSSRAP has formulated its environmental protection program to meet the requirements of this order and the regulatory guide.

DOE Order 5482.1B, *Environment, Safety, and Health Appraisal Program*, establishes a review and appraisal program for the Environmental, Safety and Health (ES&H) programs at WSSRAP. There are six levels of appraisals and audits: management appraisals, technical safety appraisals, functional appraisals, internal appraisals, environmental surveys, and environmental audits. Each appraisal and audit requires a quarterly status report or a report as otherwise directed, to report on corrective actions.

DOE Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, outlines requirements and procedures for investigating occurrences which may impact environmental protection, safety, and health. Occurrences are categorized into three levels - A, B, and C. In addition, the Annual Radiation Exposure Information Reporting System (REIRS) requires an annual report of any exposures obtained by DOE or Project Management Contractor (PMC) employees, nonemployee radiation workers, and visitors.

9.3.1.1 Annual Site Environmental Report Description. The WSSRAP *Annual Site Environmental Report* (ASER) presents the findings of the environmental monitoring program conducted at the Weldon Spring site (WSS) in each monitoring year. The report presents summary environmental data, discusses compliance with environmental standards, and highlights significant programs and efforts undertaken at the WSS. Annual environmental monitoring reports have been prepared for this site (or portions thereof) since 1981.

This DOE Order also requires a listing of environmental permits. Existing permits and compliance with those permits is discussed in the report.

The ASER is the DOE's vehicle for documenting the results of its extensive monitoring program at the WSSRAP. The report provides the public and concerned regulatory agencies with summary level discussions regarding the routine environmental monitoring program. It explains how the WSSRAP effluent monitoring program meets the requirements of the National Pollution Discharge Elimination System (NPDES) program and compares the measured contaminant levels to applicable standards. Further, the report indicates whether changes are occurring in contaminant distribution or contaminant source conditions on and around the site--changes which might equate to variations in potential exposure scenarios to the public or environmental receptors.

Environmental monitoring is the WSSRAP's most effective means by which to assess the impacts from the site. The data and evaluations contained in the report provide the summary of that monitoring for each monitoring year. The ASER reports results of the contaminant level measurements and compares the environmental levels of radioactivity and chemical contaminants released from the site with applicable standards.

In addition to the routine environmental monitoring conducted in each monitoring year, a number of related activities and special studies are performed. These activities and studies are directly applicable to the assessment of the overall impact of site operations on the environment. Therefore, these activities are described and the results are discussed in the ASER. These include Oak Ridge National Laboratories (ORNL) research on site, Federal Facility Agreement driven activities, and activities not scoped in this EMP.

The report contains trend analyses and figures for groundwater wells, definitions of selected terms used in the report, a discussion of the environmental guidelines that apply to the monitoring program, and presents dose assessment calculations.

Though not required by a DOE Order, the *Quarterly Environmental Data Summaries* (QEDS), are produced to aid in communicating site environmental data to the public and participating regulatory agencies. The QEDS summarizes environmental data, highlights any significant findings, and offers tentative interpretations. The QEDS allow preliminary data to be reviewed by interested individuals and organizations on a more frequent basis.

Permits issued under the National Pollutant Discharge Elimination System (NPDES), provisions of the *Clean Water Act*, also require recordkeeping and reporting. Recordkeeping requirements are stated in the NPDES permits issued by Missouri Department of Natural Resources (MDNR). Discharge Monitoring Reports (DMRs) are issued on a quarterly basis to MDNR and include information on sample collection, flow, and laboratory results. If there is a noncompliance event, MDNR must receive an oral response within 24 hours followed by a written response within five days. Written reports may also need to be filed with the DMRs.

The DOE Performance Indicator Program (PI) is a requirement of SEN-29-91, that calls for the production of a quarterly report. This program allows trending and analyzing operational data which will improve the DOE and contractor line management control of operations. The report contains a management summary, a PI summary, trends and analysis, and quantitative data.

Under the Federal Facilities Agreement, DOE must submit status reports of activities and technical documents to EPA for their review and approval. These include, but are not limited to, the ASER, EMP, QEDS, sampling plans, and unplanned sampling activity notifications. Each of these reports have their own reporting requirements and time constraints which are detailed in the *Federal Facility Agreement Implementation Plan* (MKF and JEG 1991g).

Other reports covering environmental issues are produced by the Environmental Compliance Department. The *Quarterly Compliance Report* is required by SEN-7-89. This report covers issues of non-compliance for the quarter with corrective actions. Also, the *Annual Report on Environmental Permits* is issued annually to the DOE. this report is required by DOE Order 5400.2 and covers all environmental permits issued to the site.

9.3.2 Records

DOE Order 5400.1 requires that all environmental surveillance and effluent monitoring records, computer programs, raw data, and procedures be maintained. These records must be protected against damage or loss. The WSSRAP maintains an *Environmental Data Administration Plan* (EDAP) (MKF and JEG 1991h) which governs sampling plan preparation, data verification and validation, database administration, and data archiving.

The EDAP provides a tracking system for sampling activities. Field log books and field data forms are filled out at sample collection. A chain-of-custody (COC) form is completed and accompanies the sample until it is properly disposed of or returned to WSSRAP. A laboratory authorization form is sent along with the sample, COC, and the shipping order form to authorize testing by an off-site laboratory. The sample information, such as identification number, date, and parameters is then entered into the Environmental Sample Tracking (EST) System. EST tracks the samples, calculates costs, invoice payments, and budget reports. Upon receipt of data from a laboratory, it is reviewed through verification and validation processes. The verification process reviews data delivery, sample preservation and identification, chain of custody, holding times, and data review to ensure compliance with DQO and standard operating procedures, validation reviews and evaluates laboratory data.

Data is accessed by the DOE and the PMC using a computerized data management program developed on site, the Generic Universal Report Utility (GURU). The database allows data to be selected and sorted based on identification number and parameter. Records are protected from alteration by the user.

Other computer programs used are: the Safety, Health, And Radiation Protection (SHARP) program, the Site Wide Audit Tracking System (SWATS), and the Waste Inventory Tracking System (WITS).

All environmental data and documentation from sampling, analysis, and quality review programs are maintained in hard copy records; i.e., documents and data in written, typed, or printed forms; and electronic records, i.e., computerized records of environmental data. Original documents are transferred to Quality Assurance and stored in the WSSRAP quality control area in a fireproof safe. Copies are kept in the ES&H files. Work data files and electronic data records are maintained by the Data Administration sections and archived annually.

For a more detailed description, refer to the *Environmental Data Administration Plan* (MKF and JEG 1991h).

9.4 Environmental Activities Varying from EMP Scope

When additional characterization and monitoring activities are conducted that are not defined within the scope of the EMP, a judgement will be made by the Environmental Protection Group Manager as to the relevance of each of those activities to the overall environmental reporting requirements. An example of an activity which might be reported in the ASER is a soil or water characterization effort that exceeds the scope of those previously performed in the area. Conversely, an example of activities that may not warrant ASER reporting are what are termed "engineering characterization" efforts performed in support of various construction activities at the site. Those data would not contribute significantly to the overall understanding of the environmental conditions at the site.

During the 1992 monitoring year, it may be determined necessary to alter the scope of the monitoring program. In such case, the changes in monitoring schedule, frequency, and/or location will be authorized by the Environmental Protection Group Manager with notification given to the ES&H Department Manager. All variances from the program scope will be documented with a memorandum to project management and reported in the ASER.

9.5 Emergency Preparedness

The WSSRAP maintains on site the management and staffing structure necessary to respond to environmental and medical emergencies. Plans and procedures are in place that detail the response and reporting program, implementation criteria, and routine environmental response and safety drills. The specific plans which address these measures include: the *Emergency Response Manual* (MKF and JEG 1991j) and the *Emergency Preparedness Plan* (MKF and JEG 1991k). These plans encompass environmental emergencies, spills, fire, medical and natural disasters.

9.6 Laboratory Programs

Laboratories that are performing analysis for the *Environmental Monitoring Plan* are mainly using Contract Laboratory Program (CLP) methodologies. For certain analyses (such as radiochemical) the laboratories are using EPA 600 (drinking water), EPA 900 (radiochemical analysis of drinking water) or a method that is reviewed and approved by the PMC prior to analysis of a sample. Contracted laboratories have all submitted a site-specific *Quality Assurance Project Plan* (QAPjP) to the WSSRAP and have sent controlled copies of their standard operating procedures (SOP). The QAPjP and SOPs are reviewed and approved by the PMC prior to sample shipment to a laboratory. All of the current laboratories being used by WSSRAP have had a preliminary assessment of their facilities to make sure that they have the capability and facilities to perform work according to the specifications in their contract.

Site-specific QAPjP from laboratories consist of standard practices that ensure that the laboratory is performing high quality work. Each QAPjP prepared for WSSRAP is in accordance with the current *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1980). The laboratories also demonstrate compliance with additional QA/QC as specified in their contracts which includes: sample preparation and analytical methods; calibration of instrumentation; periodic inspection, maintenance and servicing; statistical procedures to control precision and accuracy; corrective action programs; participation in external EPA Performance Audit Program; maintenance and storage of WSSRAP records; hardcopy and electronic formatting; notification of nonconforming issues; and WSSRAP internal QC samples.

Accuracy of all chemical and radiological analyses of water media samples is monitored by the routine use of control samples. This is a requirement of many published protocols (i.e., EPA) and is good laboratory practice. At the WSSRAP, 10% of all data are routinely validated (according to the WSSRAP Data Validation procedure) including all associated control samples. Also, approximately 8% of the existing database has been validated and its overall accuracy has been determined. These accuracy values have been extrapolated to represent the accuracy of the database as a whole.

Further, for radiological analyses which use counting methods, the counting accuracy is also assessed and reported with each such data point from the laboratory. These values are presented in the database under the "percent error" field.

Specific analytical methods used by the laboratories are specified in their contracts and documented by the PMC receiving controlled copies of the SOP used by the laboratory. Any changes to the standard analytical methods are documented in the controlled SOP copies.

The details of the WSSRAP data collection and management program are included in several documents including the *WSSRAP Environmental Data Administration Plan* (EDAP) (MKF and JEG 1991h) and various ES&H department procedures. The EDAP presents the minimum detection levels for environmental sample analysis by media and parameter. The levels represent the contract required detection limits (CRDLs) under the EPA Contract Laboratory Program (CLP) and represent the levels to which the laboratories are required to perform. Often times the laboratory instruments can achieve lower levels based upon the calibration, operational efficiency, and sample media and concentrations. In such cases, this instrument detection limit (IDL) is requested to be reported. Analyses for nitroaromatic compounds are performed according to USATHAMA-approved methods, which generally achieve lower detection levels than EPA Method 609. For water analyses, all samples are analyzed first by gas chromatography, with all positive detection confirmed with high performance liquid chromatography (HPLC). Radiological analyses are conducted by either EPA Method 520/5-84-006 or EPA Method 600/4-80-032. Again, these minimum detection levels are reported in the Appendix of the WSSRAP *Environmental Data Administration Plan.*

10 QUALITY ASSURANCE

Quality assurance (QA) for environmental monitoring activities at the Weldon Spring site (WSS) is divided into two separate categories. The first, programmatic or overall project QA, relates to the incorporation and documentation of the quality of all site activities. This approach is discussed in section 10.1. The second category is specific to the environmental monitoring activities presented in this plan and is discussed in Section 10.2.

10.1 Programmatic Quality Assurance

The Weldon Spring Site Remedial Action Project (WSSRAP) is obligated to comply with the requirements of American National Standards Institute (ANSI) and American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance Program-1 (NQA-1-1986) as outlined in DOE Order 5700.6B. These requirements were developed to assure that work performed at facilities handling, processing, or utilizing radioactive materials is of documented quality. To satisfy this obligation, Morrison Knudsen Corporation has prepared a corporate *Quality Assurance Manual* (MKC 1991) which addresses's the requirements of NQA-1. This corporate plan is consistent with the 18-element format of NQA-1. In addition to this corporate plan, the Project Management Contractor (PMC) has prepared a project specific quality assurance program plan (QAPP) which details how the various aspects of NQA-1 and MK-Ferguson's quality assurance program, as described in the corporate QA manual will be implemented at the Weldon Spring site. This QAPP has been reviewed and approved by project management, the project's Quality Assurance Manager, and the U.S. Department of Energy (DOE) Project Manager.

The QAPP details numerous ANSI/ASME NQA-1 requirements which support, control, or guide the environmental monitoring program. These requirements include: documented project organization, a documented quality assurance program, a document control system, the identification and control of items, inspections, the control of measuring and test equipment, handling, storage, and shipping of quality-affecting items, a program for implementing and verifying corrective action, a program for maintaining quality assurance records, and a routine audit program. QA procedures detail implementation of these requirements. Specific procedures include: QAPP-8, *Nonconformance and Corrective Action*, QAPP-9, *Quality Assurance Records*, QAPP-10, *Audits*, SQP-1, *Site Wide Audit Tracking System* and SQP-2, *Quality Assurance Surveillance*.

The WSSRAP also has prepared an environmental QAPP (EQAPP) to meet the intent of EPA QAMS 005/80. This document supports the project QAPP and is specific to environmental monitoring and characterization. Effective February 1992, the QAPP and EQAPP will be revised to meet the requirements of DOE Order 5700.6C. Root cause analysis and lessions learned will be addressed by a WSSRAP specific document which is presently being drafted and will be completed in 1992.

10.2 Environmental Monitoring Program Quality Assurance

The quality of the environmental monitoring program is maintained and documented through a number of measures described in the following subsections. The measures include: the use of standard operating procedures, the collection, analysis, and evaluation of quality control samples, performance audit samples, the use of standardized analytical methods, data management activities (data verification), data quality evaluation (data validation), maintaining quality assurance records, performing self assessments, supporting project quality assurance personnel in auditing and evaluating analytical laboratories, and audits by quality assurance personnel. Each of these items will be discussed in the following subsections.

10.2.1 Standard Operating Procedures

Standard operating procedures (SOPs) have been developed for routine activities associated with environmental monitoring at the Weldon Spring site. These procedures have been developed from U.S. Environmental Protection Agency (EPA) and DOE guidance and from standard industry practices and are specific to the WSS. Procedures at the WSS are prepared, reviewed, and approved by cognizant department managers, the Quality Assurance Manager, and project management. Controlled copies of procedures are maintained in accordance with the document control requirements of ANSI/ASME NQA-1. Procedures are reviewed at least annually and revised as appropriate.

Personnel undergo training specific to their responsibilities varying from procedure review through classroom training and "hands on" training under the supervision of a qualified individual. This training is tracked through the use of a training matrix. Each manager prepares for each individual a unique subset of procedures from all site procedures. Training records are maintained by the Productivity Improvement Coordinator. As procedures are revised, the matrices are updated and personnel are retrained.

TABLE 10-1 Procedures Applicable to Environmental Monitoring Activities

Procedure Number	Procedure Title
ES&H 4.1.1	Environmental Numbering System
ES&H 4.1.2	Chain of Custody
ES&H 4.1.3	Sampling Equipment Decontamination
ES&H 4.1.4	Packaging and Shipping Requirements for Non-regulated Samples
ES&H 4.3.1	Surface Water Sampling
ES&H 4.4.1	Groundwater Sampling
ES&H 4.4.2	Groundwater Level Monitoring and Well Integrity Inspections
ES&H 4.4.5	Soil/Sediment Sampling
ES&H 4.5.1	Ph and Temperature Measurements in Water
ES&H 4.5.2	Specific Conductance Measurement in Water
ES&H 4.5.7	Measurement of Settleable Solids
ES&H 4.5.8	Water Sampling Filtering
ES&H 4.6.1	Area TLD Deployment for Environmental Sampling
ES&H 4.6.2	Radon Concentrations Measurement in Ambient Air
ES&H 4.6.4	Constant Flow Air Sampler Operation and Sample Filter Handling
ES&H 4.6.6	Constant Flow High Volume Air Sampler Operation and Sample Filter Handling
ES&H 4.9.1	Environmental Monitoring Data Verification
CM&O-15	Task-specific Safety Assessments
RC-30	Monitoring Well Waste Management
RC-31	Environmental Monitoring Data Validation

Procedures applicable to environmental monitoring activities are listed in Table 10-1. These procedures cover all activities from groundwater sampling through chain-of-custody samples and provide detailed instructions to monitoring personnel.

10.2.2 Quality Control Samples

Numerous QC samples are collected in support of environmental monitoring activities. These include: duplicate samples, replicate samples, blank samples, and rinsate samples. Samples are also provided to the laboratory to perform internal laboratory quality control evaluations specific to sample media (matrix spikes and matrix spike duplicate samples). Table 10-2 presents a summary of the various quality control samples that will be collected to support environmental monitoring activities. Duplicate samples will be collected on a frequency of one per 20 samples collected or one per every 14 day period during which samples are collected if the sampling, by matrix, yields fewer than 20 samples during that period (EPA 1989). The WSSRAP will also participate in the DOEs laboratory cross-check program for radiological and chemical sample analyses. Performance audit samples prepared by an off-site laboratory will be submitted to WSSRAP-contracted laboratories for an evaluation of analytical performance.

10.2.3 Analytical Methods

Standardized analytical methods will be used to perform analyses related to environmental monitoring. This, combined with duplicate and replicate samples, will ensure that environmental monitoring results are comparable. The analyses to be performed and the analytical methods that will be used are discussed in Section 6 of this plan.

Each laboratory is required to prepared a project-specific *Quality Assurance Project Plan* (QAPjP). These QAPjPs are reviewed and approved by the WSS Project Quality Manager prior to performing analyses for the WSS.

10.2.4 Data Management Activities

Overall environmental data management activities for the Weldon Spring site are detailed in the *Environmental Data Administration Plan* (EDAP) (MKF and JEG 1991h). The EDAP provides guidance for the development of sampling plans, describes data management activities, and details general data quality requirements. These general data quality goals have been

Table 10-2 Field Quality Control Sample Summary

QC Sample Type	Frequency	Purpose
Duplicate	*1 per 20 or 1 per 14 days	Assess intralaboratory variability
Replicate	*1 per 20 or 1 per 14 days	Assess interlaboratory variability
Equipment Blank	1 per 20	Assess effectiveness of decontamination
Distilled Water Blank	1 per quarter	Assess quality of distilled water
Trip Blank	1 per day when analyzing for VOAs	Assess potential cross-contamination during shipping
Field Blank	1 per 20	Assess impact of ambient conditions on samples

* Whichever is of higher frequency

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adopted for this monitoring program. The primary activities associated with this environmental monitoring program include data verification, database management, and data validation. These programs document the quality of data generated by on-site and off-site analyses of samples.

Data verification is the WSSRAP's process of reviewing the sampling documentation and analytical data to ensure that adequate documentation is maintained and that all results are reported in compliance with established reporting requirements. All data generated by analytical laboratories are verified.

The verification process consists of: reviewing accounting aspects, reviewing sampling documentation and chain-of-custody documentation, comparing actual holding times to method specified holding times, and a review of the data for comparability with historical results. All of these activities are documented according to Environmental, Safety and Health (ES&H) Procedure 4.9.1.

Following completion of data verification, data are merged into the site database and are available for general use. All databases are backed up regularly. Access to edit the data base is restricted to maintain the integrity the computer files.

Data validation is an independent (of the analytical laboratory) formal review of laboratory records performed to assess the quality of the reported data. Actual laboratory records are reviewed by data validation personnel to determine whether the analytical instruments were within calibration and to ensure that adequate documentation is available to support the validity of the data. Data validation is performed on approximately 10% of the all data generated. Approximately 5% of these data are randomly selected by the laboratory coordinator. An additional 5% is selected for validation based on the data review. Validation activities provide the WSSRAP with qualified data. All validated data receive a qualifier that provides information for data users to evaluate the useability of the data. These activities are performed and documented in accordance with procedure RC-31a/1.

10.2.5 Quality Assurance Records

Records generated as a result of environmental monitoring are maintained as quality assurance records. Field sampling forms, analytical data, equipment calibration records, and verification and validation documentation records are all considered quality assurance records and are maintained by the Quality Assurance Department in accordance with the requirements of QAPP-9. This provides both security and protection to critical records.

10.2.6 Self Assessments

Consistent with Department of Energy Order 5482.16, the WSSRAP has developed a formal self assessment program. This program is detailed in WSSRAP procedure MGT-1. Implementation of this procedure requires that all departments perform a self assessment at least annually. Self assessments are scheduled and tracked by the Quality Assurance Department and are performed by a team led by the manager of the department being assessed. A report which summarizes the areas evaluated and the assessment results is prepared following each self assessment. Findings and proposed corrective actions are tracked according to the Site Wide Audit Tracking System (SWATS).

10.2.7 Audits

Three aspects of the WSSRAP are audited to evaluate the quality-related activities of the environmental monitoring program. These include analytical laboratories, sample collection activities and programmatic procedures.

Analytical laboratories performing analyses for the WSS are audited annually. These audits are directed by a lead auditor from the Quality Assurance Department, with support provided by a select team of site personnel who have with knowledge of analytical methods and procedures. These audits focus on compliance with the project-specific *Quality Assurance Project Plan* (QAPjP) prepared by the laboratories prior to performing sample analysis and with laboratory-specific procedures and policies. An audit report is generated and corrective actions tracked by the QA Department.

The WSS QA Department routinely audits site operations, including environmental monitoring activities. These audits evaluate compliance with project-specific procedures. As with all other audits, an audit report is generated and corrective actions are tracked by the QA Department.

The Weldon Spring site is also routinely audited by numerous external entities including DOE - Headquarters and DOE - Oak Ridge. These audits assess compliance with applicable regulations, DOE orders guidance, site plans, and procedures. Formal reports and corrective actions are tracked using the SWATS.

11 REFERENCES

Argonne National Laboratory, 1990a. *Feasibility Study for Management of the Bulk Wastes at the Weldon Spring Quarry*, Weldon Spring, Missouri. DOE/OR/21548-104. February.

Argonne National Laboratory, 1990. *Draft Plan for an Ecological Assessment in support of the RI/FS-EIS for the Weldon Spring Site Remedial Action Project*, Weldon Spring, Missouri. October.

Bechtel National, Inc. 1984. *Radiological Survey Report for the Weldon Spring Raffinate Pits Site*, DOE/OR/20722-7 (DE84015853). Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. Oak Ridge, TN. August.

Bechtel National, Inc. 1985. *Draft Radiological Survey Report for the Weldon Spring Quarry*, DOE/OR/20722-70. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. Oak Ridge, TN. August.

Bechtel National, Inc. 1985. *Weldon Spring Site Environmental Monitoring Report Calendar Year 1984*. DOE/OR/20722-58. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. Oak Ridge, TN. July.

EG&G, 1977. *On Site Discharge Information (ODIS) Users Manual.*

Eckerman, K.F., A.B. Wolbarst, and A.C.B. Richardson, 1988. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion: Derived Guides for Control of Occupational Exposure and Exposure-to-Dose Conversion Factors for General Application, Based on the 1987 Federal Radiation Protection Guidance, Federal Guidance Report No. 11.* U.S. Environmental Protection Agency, Office of Radiation Programs, Oak Ridge National Laboratory, Oak Ridge, TN.

EPA, see U.S. Environmental Protection Agency.

Federal Interagency Committee for Wetland Delineation, 1989. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands.* U.S. Army corp of Engineers, U.S. Environmental Protection Agency. U.S. Fish and Wildlife Service and USDA Soil Conservation Service. Washington DC.

FICWD, See Federal Interagency Committee for Wetland Delineation

Gilbert, R.O., and R.R. Kinnison, 1981. "Statistical Methods for estimating the mean and variance from radionuclide data sets containing negative, unreported or less-than values", *Health Physics* 40:377-390.

Haroun, L.A., J.M. Peterson, M.M. MacDonell, and I. Hlohowskyj, 1990. *Baseline Risk Evaluation for Exposure to Bulk Wastes at the Weldon Spring Quarry, Weldon Spring, Missouri*. DOE/OR/21548-065. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office, Weldon Spring Site Remedial Action Project by Argonne National Laboratory, Environmental Assessment and Information Sciences Division. January.

MDOC, see Missouri Department of Conservation.

MK-Ferguson and Jacobs Engineering Group, 1987. *Plan for Determination of Biological Uptake of Radionuclides and Nitroaromatics in Species in the Food Pathways at the WSS*. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. June.

MK-Ferguson Company and Jacobs Engineering Group, 1988a. *Hydrogeologic Investigations Sampling Plan*, Rev. 0. DOE/OR/21548-020. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. November.

MK-Ferguson Company and Jacobs Engineering Group, 1988b. *Work Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the Weldon Spring Site, Weldon Spring, Missouri*. DOE/OR/21548-033. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. August.

MK-Ferguson Company and Jacobs Engineering Group, 1988c. *Phase I Spring and Seep Report*, Rev. 0. DOE/OR/21548-045. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. November.

MK-Ferguson Company and Jacobs Engineering Group, 1989. *Annual Site Environmental Report for the Weldon Spring Site Remedial Action Project, 1989*. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. November.

MK-Ferguson Company and Jacobs Engineering Group, 1991a. *Environmental Protection Program Implementation Plan*. Rev. 2. DOE/OR/21548-095. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. April.

MK-Ferguson Company and Jacobs Engineering Group, 1991b. *Groundwater Protection Program Management Plan*. Rev. 2. DOE/OR/21548-123. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. September.

MK-Ferguson Company and Jacobs Engineering Group, 1991c. *Aquatic Biological Screening Investigation*, Rev. 0. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. April.

MK-Ferguson Company and Jacobs Engineering Group, 1991d. *Annual Site Environmental Report for Calendar Year 1990*, Rev. 1. DOE/OR/21548-193. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. September.

MK-Ferguson Company and Jacobs Engineering Group, 1991e. Specification Section - *WP181 Draft Sampling Plan Aquatic Biological Screening Investigation*. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. April.

MK-Ferguson Company and Jacobs Engineering Group, 1991f. *Agricultural Sampling Plan*. DOE/OR/21548-229. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri.

MK-Ferguson Company and Jacobs Engineering Group, 1991g. *Draft Federal Facility Agreement Implementation Plan*. Rev. 0. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. March.

MK-Ferguson Company and Jacobs Engineering Group, 1991h. *Environmental Data Administration Plan*, Rev. 1. DOE/OR/21548-119. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. April.

MK-Ferguson Company and Jacobs Engineering Group, 1991i. *Environmental Quality Assurance Program Plan*, Rev. 0. DOE/OR/21548-238. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. In press.

MK-Ferguson Company and Jacobs Engineering Group 1991j. *Emergency Response Manual*. Rev. 0. DOE/OR/21548-196. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. August.

MK-Ferguson Company and Jacobs Engineering Group 1991k. *Emergency Preparedness Plan*. Rev. 0. DOE/OR/21548-2243. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, Missouri. September.

Missouri Department of Conservation, 1991. *Recreational Use of Weldon Spring Wildlife Area 1989-1990*. Public Profile 6-91. June.

Morrison-Knudsen Corporation Construction Group, 1991. *NQA-1 Quality Assurance Program*. First Issue. April.

Quinlan, J.F., 1989. *Groundwater Monitoring in Karst Terrains: Recommended Protocols and Implicit Assumptions*. EPA600/X-89/050. Prepared for the U.S. Environmental Protection Agency in cooperation with the National Park Service. Las Vegas, Nevada. February.

Rosner, B., 1975. On The Detection Of Many Outliers. *Technometrics* 17:221-227.

Ryckman/Edgerley/Tomlinson and Associates, 1978. Phase III Report: Assessment of Disposal Alternatives. St. Louis, MO.

RETA, see Ryckman/Edgerley/Tomlinson and Associates.

Strenge and Bander, 1981. MILDOS - "A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations," NUREG/CR-2011; PNL-3767, prepared by Pacific Northwest Laboratory, Richland, Wash., for U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Department of Energy, 1991. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. DOE/EH-0133T. Washington, DC. January.

U.S. Environmental Protection Agency, 1980. *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*. EPA/QAMS 005/80. December.

U.S. Environmental Protection Agency, 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*. OSWER-9950. September.

U.S. Environmental Protection Agency, 1989. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*.

U.S. Environmental Protection Agency, 1989. Risk Assessment Guidance for Superfund Vol. II Env. Evaluation Manual. Interim Final. EPA/540/1-89/001. March.

U.S. Environmental Protection Agency, 1989. *USEPA Contract Laboratory Program—Statement of Work for Inorganics Analysis: Multi-Media, Multi-Concentration*. SOW No. 788.

U.S. Fish and Wildlife Service, 1984. National Wetlands Inventory Map.

Yuan, Y.C., J.H.C. Wang, and A. Zielen, 1989. MILDOS-AREA: An Enhanced Version of MILDOS for Large-Area Sources, ANL/ES-161, prepared by Argonne National Laboratory, Energy and Environmental Systems Division, Argonne, IL. for U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN. June.

DOE ORDERS

5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5400.3A	Occurrence Reporting and Processing of Operations Information
5482.1B	Environment, Safety, and Health Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements

PROCEDURES

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ES&H 4.1.2	Chain of Custody
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ES&H 4.3.1	Surface Water Sampling
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CM&O-15	Task-specific Safety Assessments
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RC-31	Environmental Monitoring Data Validation